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Vol. 5 No. 57 (New Series)

SEPTEMBER, 1959

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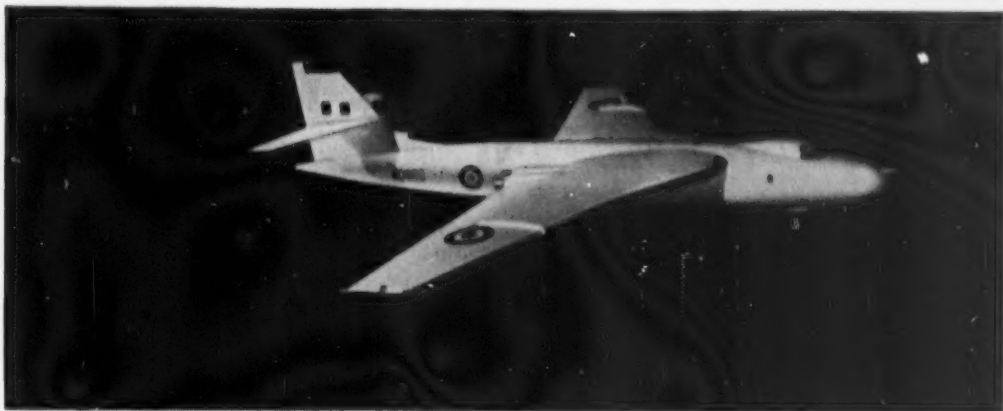
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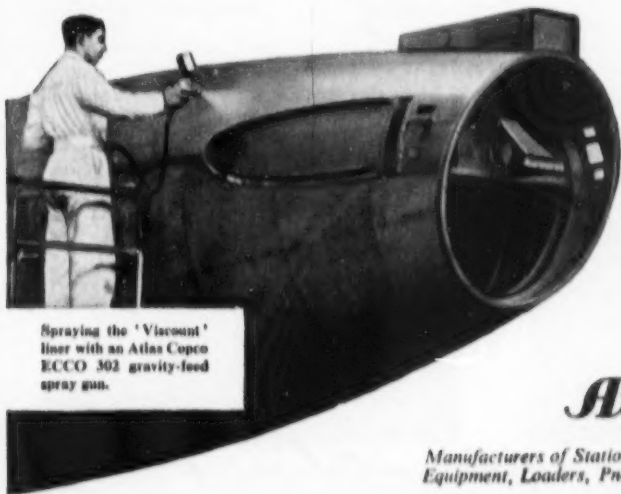
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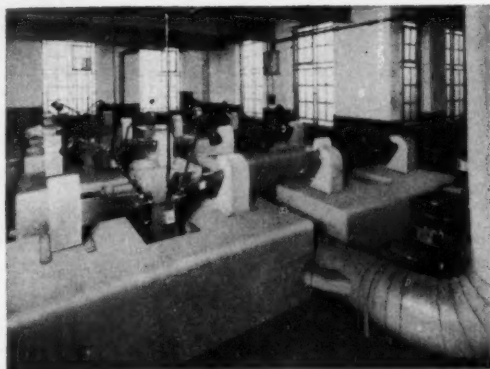
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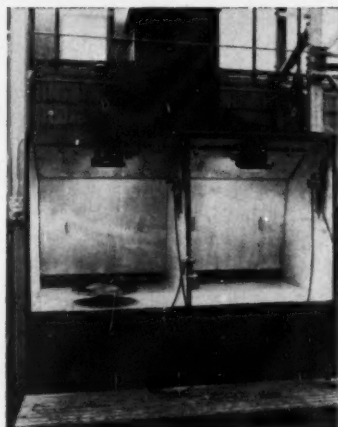
metal finishing

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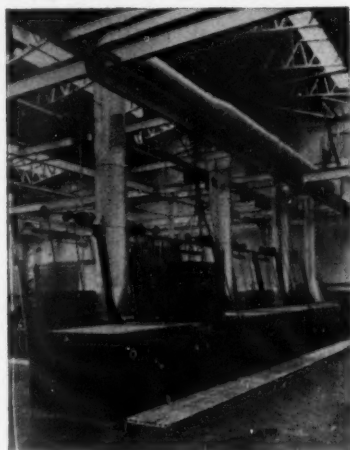
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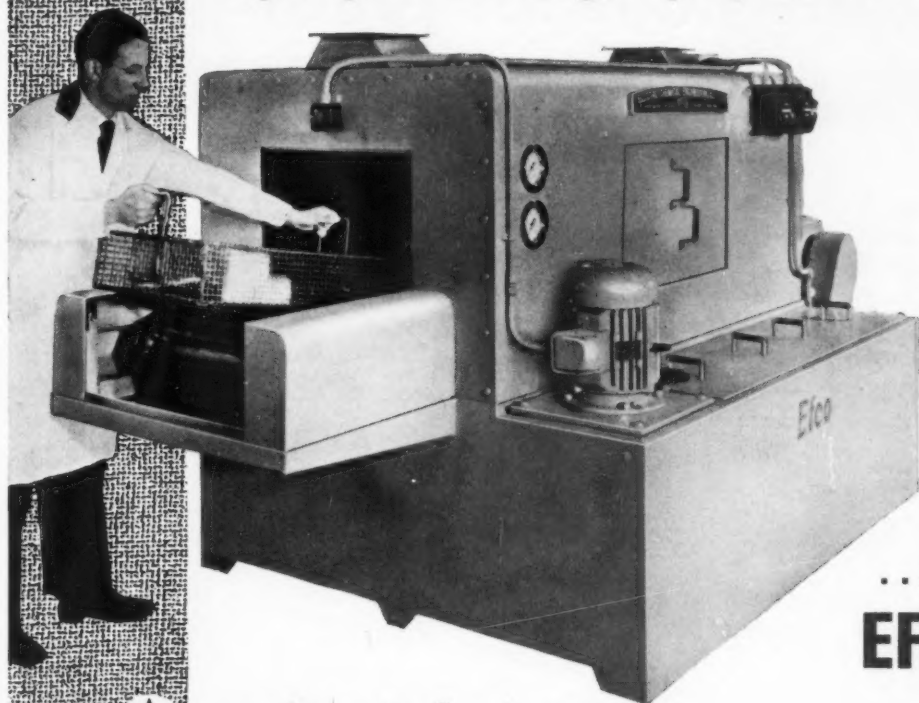
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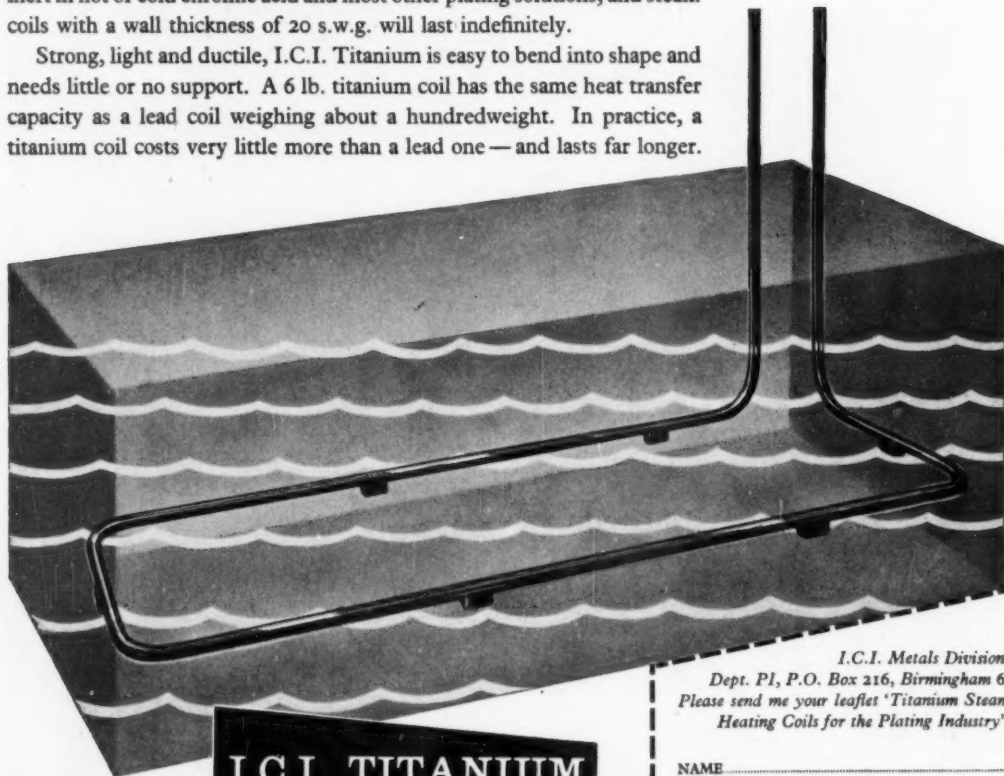
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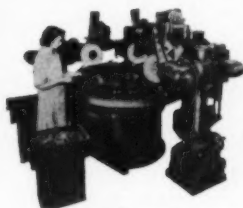
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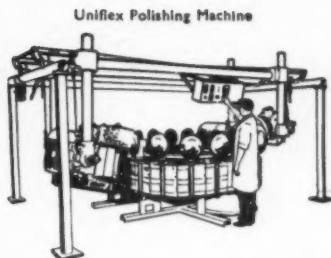
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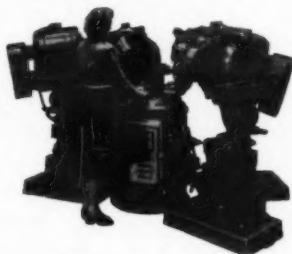
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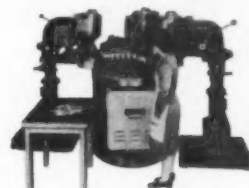
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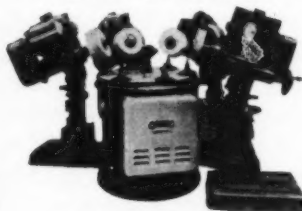
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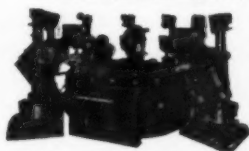
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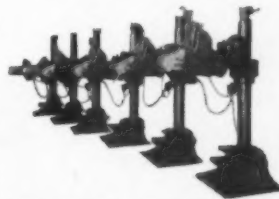


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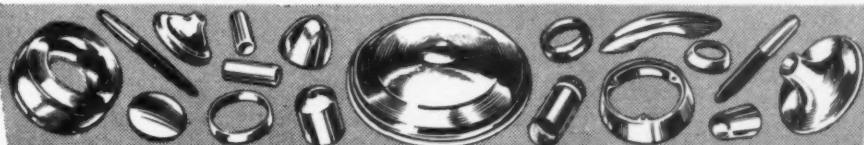


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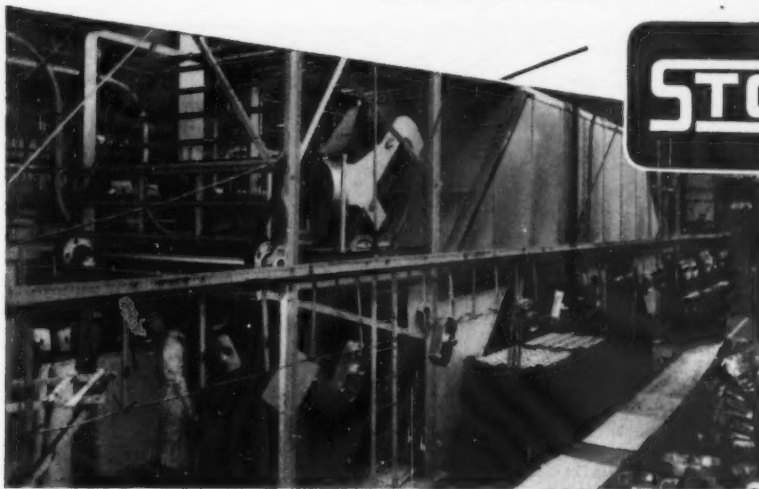
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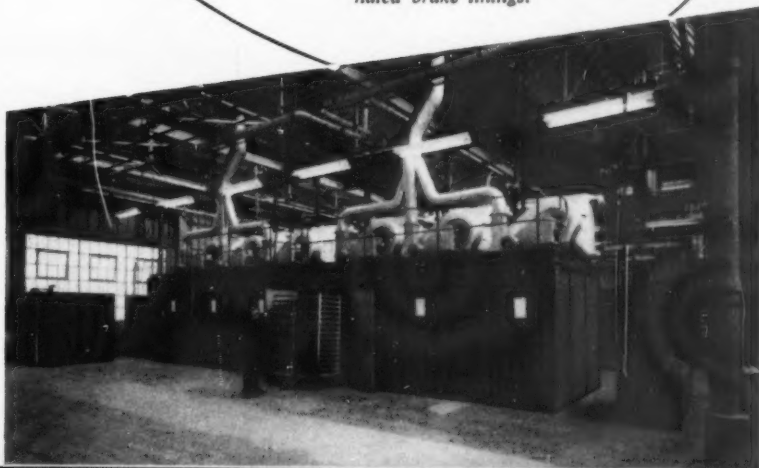
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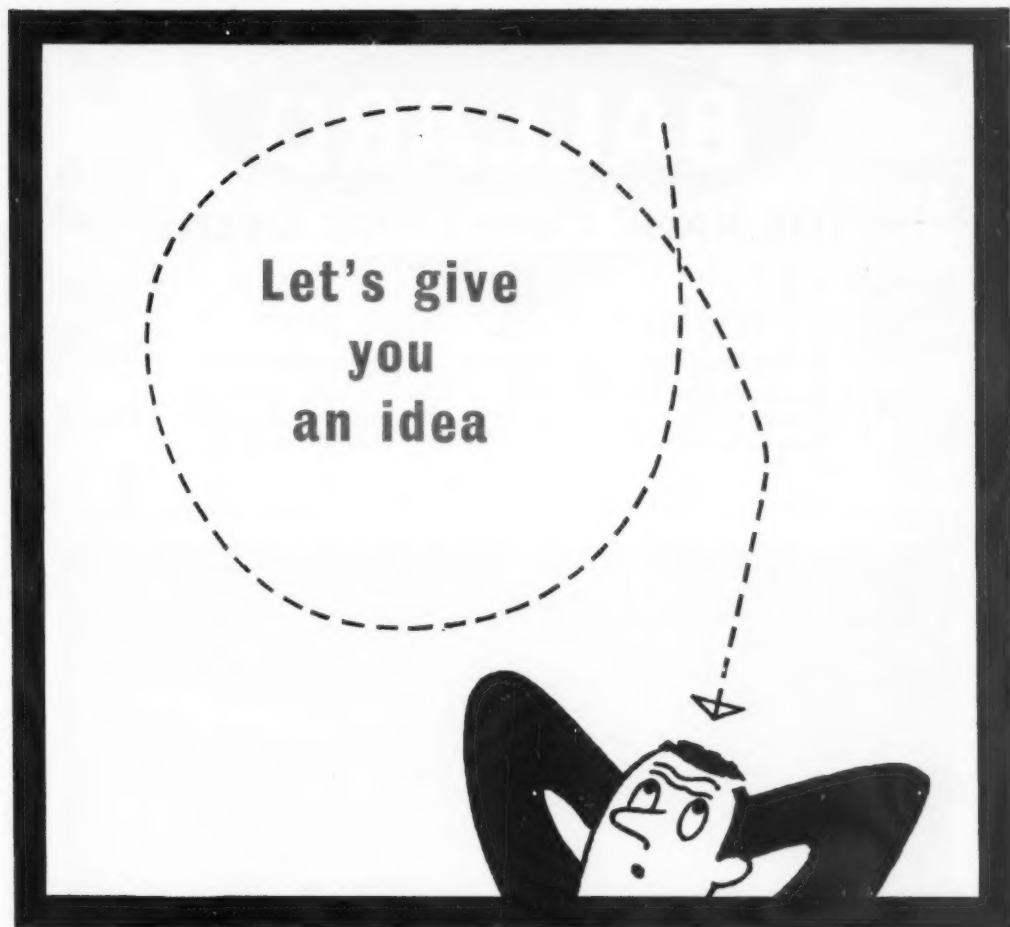
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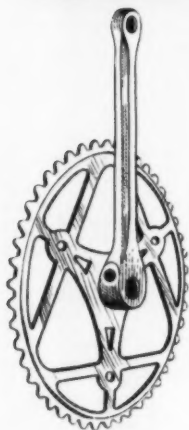
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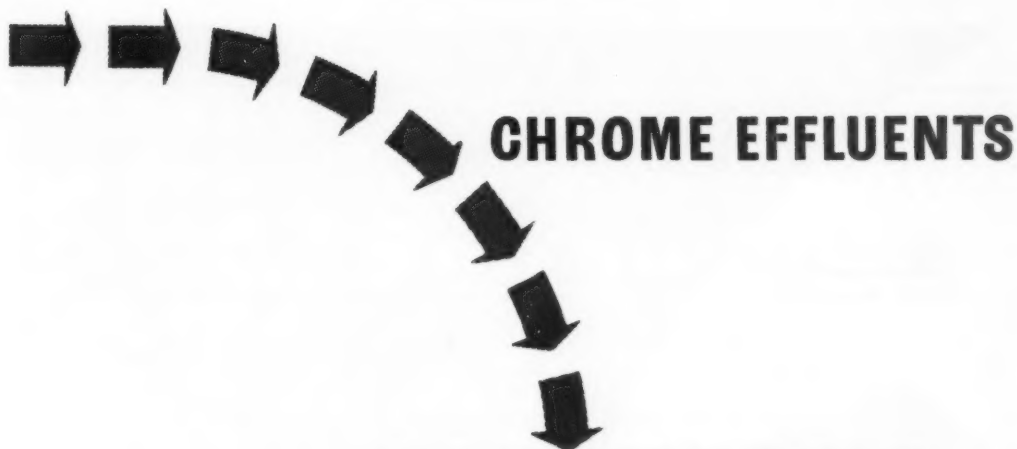


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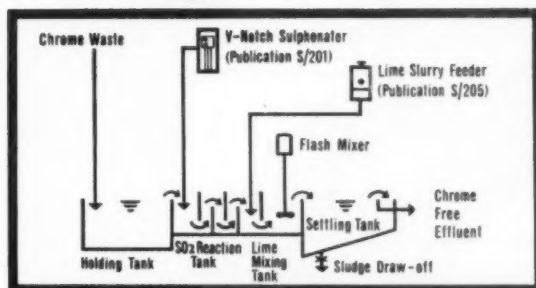
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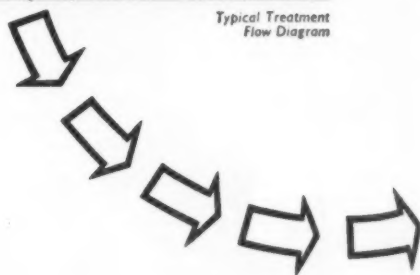


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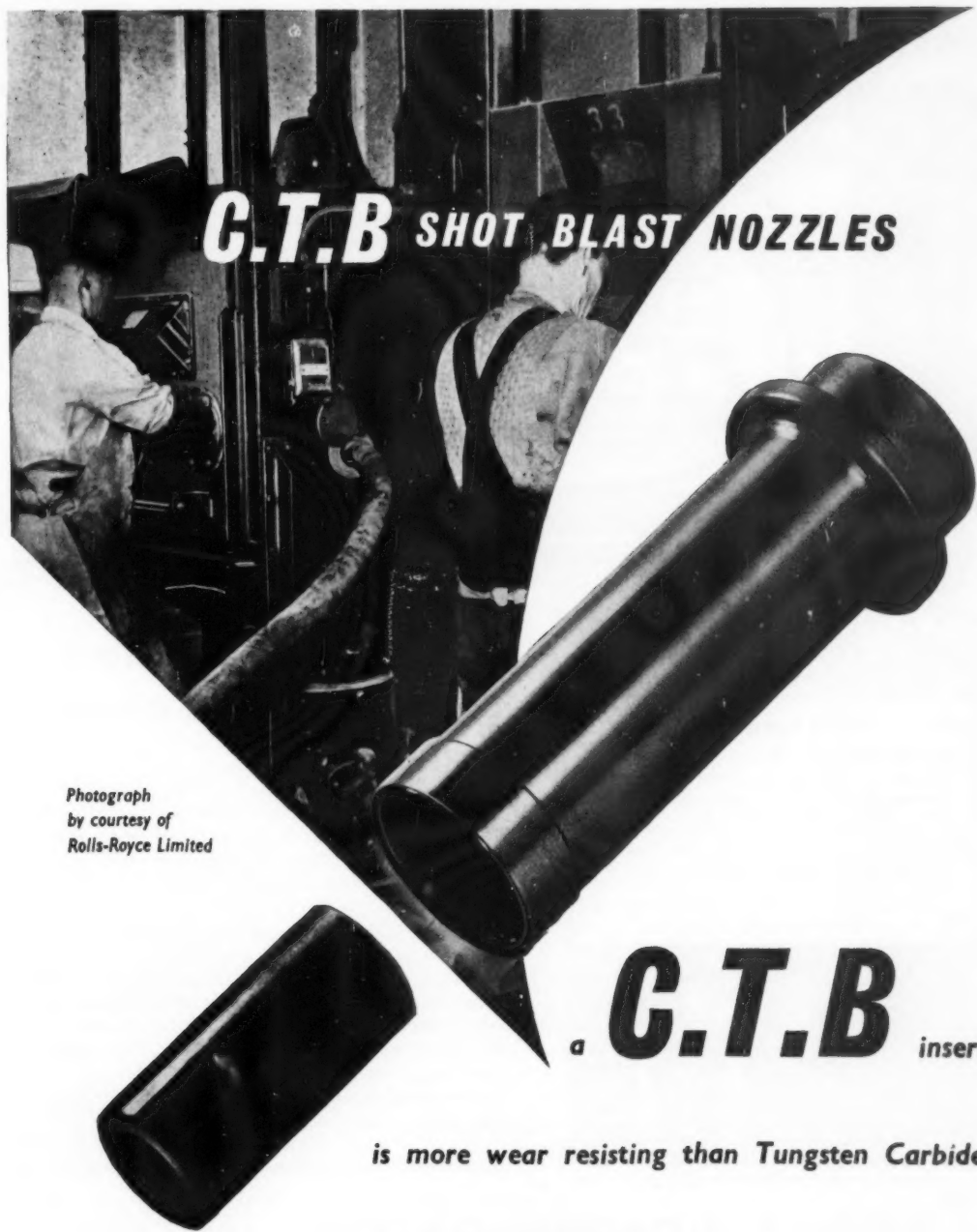
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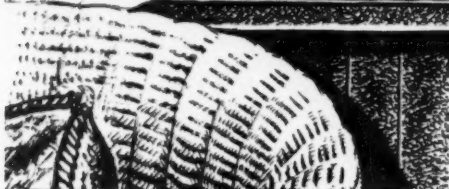
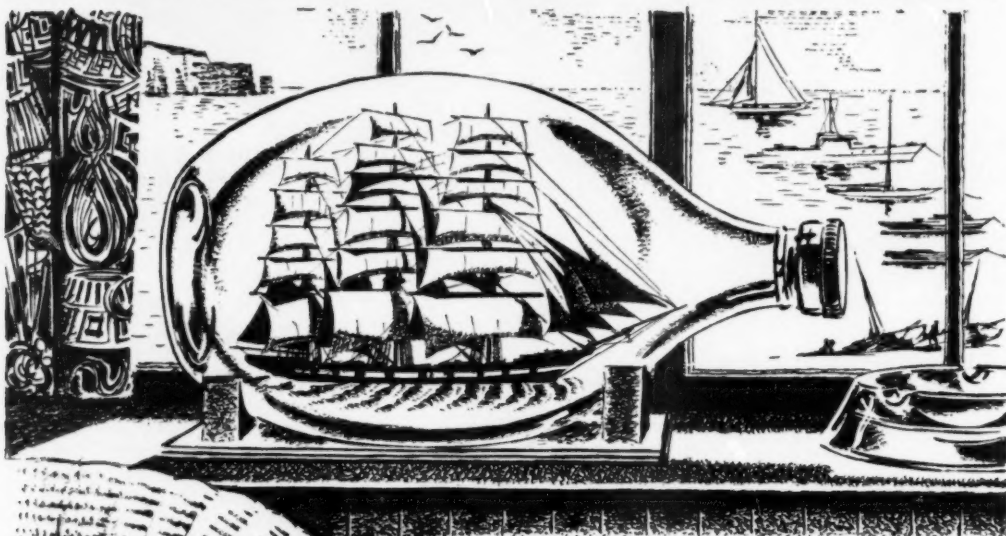
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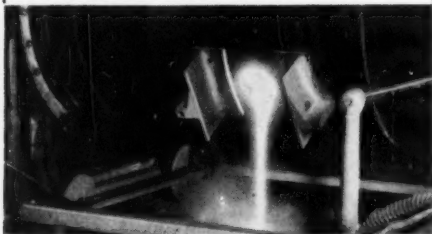
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TGA BX 154A

metal finishing Journal

September, 1959



Vol. 5, No. 57 (New Series)

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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TIME, GENTLEMEN, PLEASE

MAN is a social creature and his gregarious tendencies have increased markedly in recent decades even in this country notwithstanding the Englishman's widely recognized preference for splendid isolation in first-class railway compartments.

One manifestation of man's growing tendency to foregather with his fellow men has been the extension of the practice of holding conferences; conferences on widely different scales and at very different levels, devoted to discussion of a host of subjects.

So deeply ingrained is this conference habit that there is a growing danger of it turning into an automatic reflex and the holding of a conference becoming an end in itself so that the primary reasons for holding it are lost sight of. Fundamentally there are two reasons for holding a conference, and these could be broadly summarized as information and discussion. The emphasis between those two primary purposes frequently varies from conference to conference; in one case people may gather together to hear one or more experts discourse on their special subjects, so that, after hearing them and after questioning them, the audience will be better informed. In other cases a number of experts will get together to hear theories reported so that these may be discussed and progress made in interpreting known facts.

It is important that the organizer of a conference, when planning his programme, should have a reasonably clear idea as to which of these primary approaches is the more important in his particular case. This is necessary because the programme planning should take a different form, according to the emphasis. If the chief purpose is the dissemination of information then all that is necessary is to empanel an authority, provide sufficient chairs for all those who wish to hear him speak and make sure that he is audible to all of them. Provision can also usefully be made for questions to be put after the delivery of the address so that any obscurities or uncertainties can be resolved. If, on the other hand, it is intended that the conference session shall partake of a genuine discussion in which experts of equivalent standing shall discuss publicly one with another their findings and views on various subjects the requirements are obviously somewhat different. The basic premises of the discussion must be clearly set down, preferably well in advance of the meeting, so that those who are attending can have sufficient time to study them and muster their own arguments.

There have, this year, been two important conferences available to the metal finishing industries of this country—the Annual Conference of the Institute of Metal Finishing held in Brighton, and the Fifth International Metal Finishing Conference held in Detroit. The I.M.F. Conference, in spite of the normal 3½-day period being reduced, included a greater than usual number of papers, all of which were preprinted and no recourse was had to simultaneous sessions. As a result of this the time for questions or discussion was considerably abbreviated. At the International Conference 44 papers were presented, with simultaneous sessions throughout the 5-day period of the conference and no preprints were made available, the time for discussion being limited to only a few minutes in each case.

The Detroit conference was undoubtedly a valuable and memorable experience to all those who were able to attend it, including the 30 delegates from the U.K., and no-one who was present at the I.M.F. Brighton conference this year would deny that attendance was well worth while. However, it is perhaps pertinent to enquire at this point whether such conferences should be considered as occasions for packing the greatest possible number of technical contributions into the time available.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT
FROM THE MAIN
LINES AND SIDE
LINES OF METAL
FINISHING

A SURFEIT OF PROGRESS

IT certainly now looks as though the plating industry is beginning to look up, so far as producing deposits of greater durability is concerned. Hitherto the emphasis has tended to be on speed of plating, ease of control, brilliant appearance—everything in fact except quality. Now, the problem the plater has to face is a surfeit of processes each designed to give him plating which will last longer. Duplex nickel, nickel-chromium-nickel, chromium-nickel-chromium, and high temperature chromium are all competing for his attention. The latest is duplex chromium, in which a finely cracked chromium is deposited on a crack-free chromium, the theory being that the many cracks over the entire surface "disperse" the cell action over a larger area. There is therefore a substantial reduction of the current density at each of the individual openings, thus keeping the current density below the value corresponding to the critical potential required for the anodic perforation of the underlying metals. The result, it is claimed, gives even greater benefit than crack-free chromium alone.

Which way to turn is the problem many people in the industry will soon have to face. At the moment most of them are sitting on the fence awaiting developments.

BOTTLES AND GALLONS

ONE of the minor exasperations in reading American plating literature is the need to remember that the U.S. gallon is only 4/5ths of the size of the Imperial gallon. The origin of this difference dates back to the Declaration of Independence; the smaller gallon was used primarily to facilitate the importation of wine by the colonists from the Continent of Europe!

In the days of Queen Anne a special wine-gallon was introduced to conform with the wine measure then standard throughout Western Europe as the unit by which wine was bought and sold. It was this measure which the Americans standardised in preference to the English gallon, because naturally trade with this country became less important than that done with the Continent after the War of Independence.

In 1826 the Winchester gallon was standardised at 20 per cent greater than the wine gallon, which was then abolished. The wine bottle then became one sixth of a gallon, thus making it easy for the Customs to assess duty, as shillings per gallon

and pence per bottle are readily convertible without the need for a slide rule! But it looks as though the two gallons are going to stay with us for a long while to come, even if the Customs and Excise adopt computers.

KEEPING IT COOL

WITH the increasing cost of water and the problems of effluent disposal, more people are beginning to look at ion exchange systems to enable water to be re-used over and over again in a closed circuit. The capital cost of doing this is high, but the advantages are obvious. There is, however, one point which it is as well to bear in mind when putting in large scale equipment, and that is the temperature angle. One of the virtues of well or main's water for plating which is often lost sight of is that it is cold; in a closed circuit, however, the temperature of the water tends to build up constantly, and when it becomes fairly warm some unforeseen troubles may occur. Rinse tanks in one installation became so warm that drying off occurred on automatic plant between operations, whilst the water may also be unsatisfactory as a cooling medium in the water-jackets of chromium plating tanks.

It is the easiest thing in the world to lose sight of such points when considering a new project. It is often the relatively minor aspects of the operation of a plant which can spell the difference between success and failure, and although rectification is usually not difficult technically, it can be crippling expensive, so that the economic aspect of a scheme which may have appeared to be attractive at first sight becomes completely changed. By then it is too late to go back, as there is a point of no return in these matters.

BELATED REVOLUTION

"THE greatest revolution in equipment in the last five years (in the U.S.A.) has been the rapid shift from the generator to the rectifier as a source of power."

D. Gardner Foulke (Hanson-Van Winkle Munning Co.)

It is a strange thought that a very large proportion of the electroplaters in this country are not old enough to recall what a plating generator looked like, just as a high percentage of American car drivers have never seen an automobile gear lever.

SPRAYED METAL AND PLASTIC COATINGS

A Symposium

organised by the

METAL AND PLASTIC COATING ASSOCIATION

at the Charing Cross Hotel, London, on April 17th, 1959

METAL SPRAYING IN THE PROTECTION OF IRON AND STEEL

by T. P. HOAR, M.A., Ph.D., B.Sc., F.R.I.C., F.I.M.*

THE art and science of metal spraying is relatively new among the metallurgical arts generally. The names of Schoop and Schori immediately occur as two of the inventors of the metal-spraying processes. The bulk of metal spraying in this country today is done either by the wire or by the powder spraying technique; the molten-metal technique is also used but it does not seem to have the same general applicability as either the wire or the powder method.

It is appropriate briefly to compare the characteristics of the wire and powder methods of spraying how the coating is built up and what characteristics may be expected in the coating. In the wire method, a molten droplet of metal is projected through the flame on to the prepared surface. In the powder method, what has been a solid particle of powder is projected in what may be a completely solid state or may be verging upon the liquid state, through the flame on to the surface. Most of the evidence seems to show that in powder spraying melting does not usually take place.

Either of the particles travelling through the flame, if the flame is in the least oxidizing, must obtain a film of oxide on its surface. When the particle hits the surface to which it is to adhere, the metal oxide is to some degree ruptured by the flattening of the particle as it hits. In consequence, at the point of impact momentarily there is a number of metal/metal junctions that are not interfered with by an intermediate film of oxide and that consequently lead to a species of welding. The adhesion thereby produced of the particles of basic metal, and the final cohesion within the metal sprayed film, is nothing like as great as might be expected with a wrought or a cast metal, but for practical purposes it produces a metal layer that is sufficiently adherent and coherent to remain *in situ* and in electrical contact with the basis metal for many years.

A coating as built up must also contain a considerable amount of oxide at points where real metal adhesion does not occur. All sprayed metal coatings in fact show a substantial amount of oxide when examined in section under the microscope. This oxide content appears, however, to have very little influence on the degree of protection afforded by the coating. It has been shown, largely in the work of J. C. Hudson and his colleagues, that, with zinc as an example, the years of protection afforded by a zinc coating on mild steel are in direct ratio to the weight of zinc that has been deposited, and that the method of deposition of zinc, whether by hot-dipping, electrogalvanizing, spraying from the wire or spraying from the powder, has little or no effect on the protective value of the coating. These experiments demonstrate rather conclusively that the fact that sprayed coatings contain a proportion of oxide—more than is obtained in hot dipping or electrogalvanizing impairs its corrosion protection value to an extremely small, indeed negligible, extent.

Similar data are not available for aluminium coatings, but the general experience of aluminium sprayed coatings is that the thicker the coating the better the protection, at least to an upper limit at which it appears to be too cumbersome to stay on the metal very well. The upper limits of sprayed coatings for protective purposes are of the order of 10 mil, except in certain special cases. Generally speaking, however, the thicker metal coatings of all practical thicknesses give better protection for a longer time.

Another property of the sprayed coating that distinguishes it from the hot-dipped or electrogalvanized coating is the degree of porosity. It is obvious that when a coating is built up by deposition of a lot of small particles that become only partially welded one to another a considerable degree of connected porosity is left through the coating. The degree of porosity that occurs is

* Dept. of Metallurgy, Cambridge University.

usually between 5 and 15 per cent. by volume. Generally, it is found that coatings made by the powder method are somewhat more porous than those made by the wire method. This, is to be expected as the particles deposited from the powder are somewhat more angular and less spherical owing to their solid nature when they hit the growing coating. The porosity in a sprayed coating, however, is by no means a detrimental feature of a coating, except in cases such as a coating of copper on top of steel for decorative purposes, where the coating will be cathodic towards the basis metal and corrosion may well occur at the bottom of the pores of metal. With zinc and aluminium this is not the case because zinc and aluminium are anodic metals with respect to steel and afford a useful degree of cathodic protection to any steel that may be exposed at the bottom of a pore connecting the basis metal to the environment on the other side of the coating.

The case of zinc is particularly clear. If a piece of zinc and steel together are immersed in a slightly acid or slightly saline liquor the zinc becomes anode immediately and provides cathodic protection towards the steel. In the case of aluminium, the development of anodic action of the aluminium may take a little time because the aluminium contains on its surface an excellent oxide film which has to be broken down by the environment before the aluminium can give cathodic protection towards the steel. In practice, it is often found that aluminium-sprayed coatings may even show in the early stages of their exposure to the atmosphere a small amount of rust staining. After a few weeks this disappears, giving merely a rather darker appearance to the surface, rather than a rusty colour. Some years ago this was attributed by Tolley to the chemical reduction of the rust by the now active aluminium, and there is little doubt that some such action in fact takes place.

Both aluminium and zinc, apart from the little discrepancy in the early stages with aluminium, can be regarded as giving cathodic protection to any steel exposed at the basis of the pores. This is in the early stages of attack of the coating and the basis metal by the environment. In the later stages, both zinc and aluminium produce rather adherent and also compact corrosion products that are of greater volume than the metal from which they have been formed. If a coating which has stood the weather for six months of the year is examined, it will be found that on the surface there is a rather compact film of zinc oxy-carbonate or hydroxy-oxide, and that the pores show a definite degree of sealing through the production of these corrosion products in between particles where there was previously a void. This characteristic of the metal sprayed coating leads to an increase in its

protective value after exposure has begun. If the initial exposure is to an excessively severe atmosphere, either industrial or marine, it may be that a degree of breakdown is occasionally found, however, but in all normal atmospheres other than those of the very worst industrial, zinc can be taken to increase in its protective property over the first month.

The other feature of porosity which demands attention is the way in which it is used to advantage in the treatment of the sprayed metal coating after it has been made. A coating can have an oil treatment applied to it to give it further protection, and being porous, it affords a good basis for oil — very much better than an untreated metal. Still more important is the effect of any permanent organic coating, such as paint. Here the porosity provides a distinct key of the paint coating on to the metal. Moreover, it makes it unnecessary to prepare sprayed zinc coatings in any way before a priming paint is applied.

As regards the relative merits of zinc and aluminium, generally speaking, trials over the years have shown that zinc coatings on the whole are best in marine and other atmospheres containing an appreciable amount of chloride that is deposited on the metal. On the other hand, aluminium coatings show to some advantage in highly acid industrial atmospheres. In consequence, in general for the protection of a large structure in marine or semi-marine conditions zinc ordinarily would be recommended, whereas for a large structure in a highly acid industrial atmosphere it would be aluminium.

There are interesting cases where the normal situation seems to be reversed. For example, at a large factory in the North of this country making, among other things, a great deal of ammonium sulphate, tests showed many years ago that zinc was very much superior to aluminium as a protective coating for steel-work. It is true that in that atmosphere there are very severe local variations, and it is quite possible that in parts of the factory, where highly acid conditions prevail, the general use of zinc would be less effective than aluminium; but generally in that atmosphere, which can be considered as industrial, zinc is better than aluminium.

It is also true that in certain marine atmospheres aluminium has given extremely good service, although the balance is slightly in favour of zinc.

In order to see whether either metal could be improved by mixing or alloying with the other, some years ago the author started a series of experiments using pure aluminium powder, pure zinc powder and mixtures of the two at 10 per cent intervals between them. At the same time the Schori Division of F. W. Berk and Co. Ltd. and their associates prepared a series of alloy powders

of zinc and aluminium at 10 per cent. intervals. Specimens of mild steel coated with these mixtures and with the prevailing alloyed metals were exposed at five different stations in various types of atmosphere. There was a very industrial atmosphere at Stratford-le-Bow, containing an appreciable amount of sulphuric and sulphurous acid at all times. There was a reasonably salubrious atmosphere at Cambridge, where the only contamination is an occasional deluge from the main fume-chamber outlet of a chemical laboratory. There was a mild industrial almost rural atmosphere at Greenford, Middlesex where the prevailing winds blow over the countryside. There was a marine atmosphere on the Essex Coast, not very warm and not very humid. There was a very warm very humid marine atmosphere at Kure Beach in North Carolina. Altogether about 2,000 specimens were exposed about six years ago, and many of these are still in almost pristine condition. As well as the aluminium-zinc mixtures and aluminium-zinc compounds, a series of aluminium-magnesium-zinc mixtures and compounds were also investigated. Some of the alloys were quite high in magnesium, because it seemed that magnesium might be an acceptable alternative in certain cases to either aluminium or zinc. The general results are as follows.

The alloys and mixtures containing magnesium gave very good protection over the first three or four years but, in general, they are less satisfactory on the long-term than aluminium or zinc or the mixtures and compounds of aluminium and zinc. Magnesium appears to be rather too reactive a metal for use in a sacrificial anodic coating — it makes too great — in fact, unnecessary — sacrifice.

The aluminium specimens, as expected, stood up well except in North Carolina where the searching, very humid and very warm marine atmosphere has given rise to a certain amount of rusting. The zinc specimens have stood up very well except at Stratford, where the sulphuric acid, as might be expected removed most of the zinc, 3 mil., from the specimens in a matter of six years.

The aluminium-zinc mixtures, around 50 per cent, have been remarkably good in all the exposures used. Aluminium-zinc compound powders are perhaps the best of all, those between 40 and 60 per cent aluminium being rather better than either zinc and or aluminium it considered as a 'general' powder for spraying anywhere without reference to the atmosphere.

These results over six years are rather more than preliminary but rather less than final, because a 3 mil. sprayed coating would be expected, except in a bad atmosphere, to last certainly for ten years even if unpainted and for very much longer if it

has a paint system applied on top. The results are sufficiently indicative, however, to allow the prediction that in the future the compound aluminium-zinc spray, in particular cases where there is a little doubt whether to use aluminium or zinc, is the best answer of the three possibilities.

Surface Preparation for Metal Spraying

Either wet or dry grit- or sand-blasting is always said to be an essential method for the preparation of the surface. Many other possibilities have been explored in the laboratory, for example preparation to a metallurgical finish (merely as an experiment and not for practical purposes), preparation by means of acid pickling and preparation by means of alkaline degreasing.

It is probable that with a perfectly prepared metal surface produced by polishing or pickling, followed by degreasing and drying an adherent metal sprayed coating could be obtained, but none of these methods is applicable in practice. If one is required to pickle *in situ* or even in the workshop, there is the difficulty of producing a rust-free and dry surface that will remain reasonably clean and free from rust and grease during the interval between preparation and spraying — a difficulty that is almost insuperable.

The great advantage of the grit- or sand-blasting processes is that they produce a surface that is almost chemically clean — that is to say, free from grease and detritus generally. It is fairly certain that this is a much more important advantage than the advantage that they produce a surface that is slightly rough. The degree of roughness on a grit-blasted surface is really very slight, and it seems unlikely that there is much keying-in of the particle as it hits the surface. There is a slight possibility of a particle hitting a point on the surface but it must be remembered that such points are not sharp and jagged but obtuse. Perhaps a particle hitting such a hill may sometimes be impaled and a degree of mechanical adhesion result, but far more important is the fact that the surface as prepared by grit-blasting or by sand-blasting is *clean*, and contains only a very thin oxide film — 50 Å thick — to be ruptured by the impinging particle. Mechanical roughness is a minor feature in the adhesion, which is a molecular adhesion between two pieces of metal which come together because on impact their oxide films are disrupted a little sideways, allowing metal-metal contact to occur. There are no other practical ways, at present, of preparing a surface to this degree of cleanliness except sand-blasting and grit-blasting. In the laboratory, of course, it is possible to clean surfaces — but the processes there used are inapplicable on a large practical scale.

DISCUSSION

Mr. PORTER (Aluminium Development Association) said he had been interested to hear the theory of protection by plugging of the sprayed aluminium or zinc coating. He confirmed that it was this plugging of pores with alumina which gave a long life to aluminium sprayed coating on steel. His only regret was that experience with the coatings mentioned by Dr. Hoar had been no more than six years — perhaps a few years longer with other tests — because he felt that the best had not yet been seen of aluminium coatings. From examinations his Association had carried out, he believed that aluminium coatings were fully plugged after a few years. To what extent did the plugging occur with zinc oxy-carbonate? Dr. Hoar had said that the length of zinc protection was proportional to the weight of coating. Even so, it seemed that perhaps zinc oxy-carbonate did not form as good a crystal barrier as the aluminium hydroxide-oxide.

The aluminium-zinc compounds would be of great value. Did the zinc take care of the protection of the steel during the first years, preventing the rust staining and the subsequent turning of the rust to a greyish pattern, with the balance being achieved by the optimum amount of plugging of the pores afterwards?

Dr. HOAR said that he was glad of the Association's confirmation that plugging occurred in aluminium; this had been questioned but he had always accepted it and specimens which he had examined had given metallographic evidence. After many years zinc disappeared and the corrosion products with it; there was little doubt that there was first considerable corrosion product plugging of the zinc and finally a general slow attack on the zinc, the zinc oxy-carbonate, the main product under ordinary conditions, disappearing along with the zinc. The rate was quite slow; in a reasonable atmosphere, a zinc coating 3 mil thick ought to last for fifteen years by whatever method it had been applied. It would not last anything like that long of course in a highly acid industrial atmosphere.

The suggestion that the alloys and mixtures worked by the zinc giving initial protection and the aluminium then taking over might well be right, but until a number of exposed specimens were examined in detail this could not be asserted.

Mr. MURPHY (I.C.I. Ltd.) said that in a warm climate porosity might have a disadvantage. The first coat applied dried rapidly and the second coat of applied paint in a paint system might show considerable blistering. This appeared to be due to a certain amount of solvents gathering in the porous substrata of the metal while the remaining paint dried out rapidly on the surface. Had this

occurred in England? Was it recognized as a possibility by the metal-spraying firms when exporting?

Dr. HOAR said this point would be dealt with in later discussion. The answer probably lay in different paint formulations for semi-tropical application — perhaps with less solvent. He was sure that the paint firms could meet this point if asked to do so.

Mr. BUSCH-JENSEN (Copenhagen) asked whether fluxing or degreasing for electro-galvanizing — methods used in some quarters — would not be suitable for metal spraying.

Dr. HOAR replied that the various forms of pickling or fluxing used for hot galvanizing were not suitable for metal spraying, because they did not produce a surface which would remain clean and suitable for spraying for even a few minutes, let alone an hour, before the spraying process. As far as he knew, no one had had success with producing a sprayed coating without shot-blasting of some kind. No one would be more pleased than he to hear evidence to the contrary.

Dr. HOWARD (Aluminium Development Association) said that if shot-blasting or grit-blasting could not be used because the structure was already up, there might be difficulty. Would flame cleaning be any use as pre-preparation for metal spraying in those circumstances?

Dr. HOAR replied that it had been tried and found unworkable. Although flame cleaning produced a non-greasy surface, it left a heavily oxidized surface. Adherent scale was not always all removed, although rust and old paint usually were. He had never seen a flame-cleaned surface that could be called chemically clean in the same way that a shot-blasted surface was clean. Trials to see whether flame cleaning could be used for metal spraying had not been successful.

Mr. TUTCHER (Keith Blackman and Co. Ltd.) asked about the time factor in metal treatment. In the pickling process a smoother finished surface was obtained than with shot-blasting. Not such a large area was left to the atmosphere for corrosion attack. In production methods, might it be better to pickle? On the other hand, it might be possible to leave it standing longer after shot-blasting.

Dr. HOAR said the reverse was true. The increase of area due to shot-blasting was only two or three times. Moreover, pickling residues, however, well rinsed or neutralized almost invariably gave rise to a small degree of rusting. In vitreous enamelling pickling was done in hydrochloric acid and the articles transferred to very dilute hydrochloric acid for storage purposes. The sheets were taken out and allowed to dry,

whereupon a thin film of rust appeared. This was no disadvantage in vitreous enamelling, spraying and firing: the iron oxide was taken up in the vitreous enamel and in certain cases it was regarded as an advantage. But in metal spraying it was certainly a very great disadvantage. Any small amount of hydrochloric or sulphuric acid or chloride or sulphates remaining under the sprayed coating would undoubtedly be a grave disadvantage. There was little doubt, by and large, that a shot-blasted surface was the better of the two, theoretically as well as practically.

The quicker the sprayed coating could be put on the shot blasted surface the better. There were machines for grit-blasting and spraying within seconds. This was not possible in spraying on a site, but even there, if the blasting could be followed by spraying within a matter of minutes it

was better than in a matter of hours. In any case, no shot-blasted surface should be left overnight, with all the possibilities of condensation and inceptant rusting before spraying. If it had to be left overnight, it must be shot blasted again the following morning.

Mr. CUMMINS (B.I.S.R.A.) asked what the effect of metal spraying was on steel after phosphating.

Dr. HOAR said there was insufficient adhesion. It had been tried. The thick film of iron and other phosphates in the coating effectively prevented metal-metal contact which was essential for proper adhesion. The fact that there was not adhesion on a Bonderized surface was strong evidence in favour of the molecular adhesion mechanism rather than the mechanical mechanism of adhesion on a surface.

PAINTING SPRAYED METAL COATINGS

by L. A. JORDAN, C.B.E., D.Sc., A.R.C.Sc., D.I.C., F.R.I.C., M.I.Chem.E.*

FIRST, let me say that I am a metal-spray fan, but having regard to my antecedents you will not be surprised to learn that some of my satisfaction, and some of my enthusiasm for metal spraying derives from the fact that I consider it to be a good beginning for putting on a decent job of paint.

As you have been told, metal spraying goes back to 1910, with Dr. Schoop and Schori in Switzerland, but the process was soon taken up here and I would hazard the guess that this country now probably leads the field in its use. The idea of using paint to supplement the corrosion given by the non-ferrous metal by keeping that metal in good condition is a pretty old one, but for a long time there was some bias against paint on the ground, presumably, that it was, or ought to be, unnecessary, but I rather think that the dangers of fouling of the highly microporous structure of metal-sprayed surfaces has become much better recognised.

At the same time, the paint manufacturer did not like metal spray very much either, but he argued: "Well, if it does interfere with the paint business it is at least a costly process and will probably not get very far." Even now, when the use of metal-spray coating is accepted as a first-class method of protecting the steel, you may, from time to time, hear in paint circles this sort of remark: "Why paint zinc, a notoriously difficult

metal to paint, when one might just as well paint the steel without the cost of putting on the zinc?"

That, of course, is a shallow argument, and the word "notorious" there refers to massive zinc. Nevertheless, to be fair, it must be conceded that if the preparation work carried out on steel before painting were as good as the preparation work done before metal spraying, general painting performance would be better than it is. On the whole, paint does a reasonably good job, often in extremely difficult circumstances and it is not to be wondered at that, at times and for various reasons, the amplitude of behaviour is rather wide. Nevertheless, the idea prevails that three coats of paint are equal to one of metal spray and one of paint on the same well, prepared material, and I understand that there is a New Zealand specification to that effect. The difference in the outlay cost is significantly in favour of paint, but the maintenance cost is probably the other way.

It would seem, then, that the metal-spray people have succeeded in getting proper preparation in full measure—shot-blasting and the like—whereas the paint people have succeeded in doing so only in some specialized situation, of which the motor-car industry is an example. Perhaps it is that paint has always been too flexible, and, of course, paint was being used successfully before all these new-fangled ideas were invented. Even so, it is possible, even now, on occasion to see good paint work on a steel bridge still good at 30 years old or

* Director The Research Association of British Paint, Colour and Varnish Manufacturers.

more, whereas another bridge could look—and be—in a pretty bad condition in less than five.

That is just by way of introduction, and today I think that both parties would agree that things have turned out rather better than was feared, even if not quite so good as was hoped. At any rate, the tribes are at peace. The one hopes to spray more and more metal; the other hopes to fill the holes so obligingly left in it. Without going into details as to how the measurement was made, we concluded that the holes in the aluminium spray coating examined amounted to 83 per cent of its apparent volume, and 72 per cent in the case of zinc. In other words, the metal is little more than a skeletal framework in air, or in whatever replaces air later on.

The fact remains, nevertheless, that the application of non-ferrous metals, notably zinc and aluminium, applied by spray in sufficient thickness is accepted as a satisfactory and economical way of arresting the corrosion of steel, when properly prepared. I am also going to establish that however good metal spray is, of itself and by itself, in ordinary life, in the rather tough conditions in which things have to be used, there is much to be said in favour of applying some paint—and of applying it quickly. A really long life can then be expected.

One of the questions that I am sure will be asked is: "That being so, what sort of paint—or does it not matter? And ought those voids to be filled?" Again, some may be thinking: "This seems a bit odd. Surely both zinc and aluminium have remarkably good resistance to the weather. Do we not have aluminium aeroplanes, aluminium coaches, galvanized iron?" That is true, but the porous structure of sprayed metal is very different from the massive form and there are many agents of deterioration—mostly chemical in character—able to get at it.

We live and work in some pretty foul atmospheres. There are the traditional items like the sulphurous gases, equivalent to a vast output of sulphuric acid, and the chlorine content of coal which, although less in amount than sulphur is as vicious—perhaps more so—in its results, while the conjunction of the two is really something! But there are new items, too. Some 40,000 tons of rubber tyres are ground to dust on the roads of London alone every year. Even in that quiet, little suburb of Teddington, where I rest from time to time, which seems to do nothing more exciting than to burn coal in its domestic fireplaces, the rainwater brings down copper at one part in ten million—and iron, too, in a big way.

We also have to reckon with the fact that much of Great Britain is industrial, and, with the best will in the world, industry means air pollution—even if it is not black—and such pollution travels far. In addition, very few places are far from the sea, and whilst sea breezes do not pollute they

bring their own troubles to steel, to paint and to sprayed zinc and aluminium.

I was asked in dealing with the problems of painting sprayed metals to spread my observations back into the realms of corrosion theory. This is a field of study and interest which for the past forty years or so has carried to glory a goodly company of prophets, both major and minor. I never made the grade. Definitely, I am not an authority on corrosion, or even on anti-corrosion, although I could tell a pretty good tale as to how red lead does its job—but that subject is not on the agenda: Incidentally, an "authority" has been defined as an individual who does not have to defend his opinions—other people are expected to be logical.

I am rather in the position of the student who, being invited in a theological examination to try an essay about the major and minor prophets of Israel, wrote: "Far be it from me to discuss and compare the merits of these holy men and their works. Rather would I prefer to describe the journeyings of St. Paul." Dr. Hoar, in his previous paper, gave a most skilful presentation of his subject, and I think the approach for me is not to touch overmuch on corrosion theory.

At the same time, at the Paint Research Station we concern ourselves with these things from time to time, and especially with those aspects of corrosion which have some bearing on paint technology and paint usage. We do keep a keen, if wary, eye on corrosion theory. There is nothing light-hearted about this, nor is it unusual, for every industry has, in some degree, its own specific corrosion problems. Those who have to think on these things ultimately have to depend on the fundamental studies even if they have concurrently to initiate complementary investigations of an *ad hoc* character before a particular problem is solved.

As I see it, the only aspects of the subject with any corrosion potential to which I must refer are, first, the environment—to which I have already referred—of our particular assembly of metals, namely, the steel, and the zinc or aluminium with which it is covered, more or less; and second, the physical form and porous structure of the sprayed metal, which is so utterly different from the same metal in massive form—in chemical activity, in surface area, and in all the features that obviously arise therefrom. Then there are the effects of the natural oxide layers, which have extraordinarily protective powers when complete though when disturbed or removed—as during preparation of the metal surface—or broken, can cause extremely rapid corrosion to develop. There is cause for debate about oxide formation and its possible effects, but it is generally conceded that sprayed metal as laid down contains a broken oxide film averaging about 2½ per cent by weight, but that the oxide content rapidly increases by exposure.

It is fair to assume that the metal droplets as they reach the target are roughly spherical, and that they flatten against the base. The cross-section of the metal coating has a rough wave form, and in general, the coating is not very strong in the transverse direction. The size of the particles is, I suppose, about 0.01 mm., and I think that the voidage is considerable. The porosity allows moisture, oxygen and other electrolytes to get in, and when they get in they soon make a disturbance.

During the years, we have examined many specimens of metal spray on steel, on glass and on Perspex—in the two latter cases so that both sides can be examined and sections taken for microscopical examination. We also check what happens when the spray is fresh, when it is old, and what happens after the application of sundry coatings—by visual appearance. There is little doubt that any thinnish penetrating liquid quickly gets through freshly-sprayed metal and reaches the base material apparently without obstruction, though pigment is filtered out. After a time, the sprayed metals build up their own corrosion product to provide something of a barrier, but, personally, I do not fancy the idea of depending on those sprayed metals building up their own corrosion protection. In any case, there is loss of metal, and I submit that the best impermeable barrier is conveniently supplied as an organic coating which protects the sprayed metal and, in the long run, helps to keep corrosive influences from getting to the steel, which is often not so far away as the thickness of the sprayed metal may suggest.

Turning again to environment, zinc spray corrodes very rapidly in the presence of chlorides and sulphates—and there is plenty of them about—and we have seen some disastrous results from this cause. Clearly, chloride attack is to be expected in marine atmospheres, but atmospheric sulphur compounds can also build up corrosion product in situations remote from large towns, even on the coast, and gradually the sacrificial protection conferred by a coating of unprotected zinc diminishes and can be exhausted.

Just to give an idea of the extent of this attack, an experimental record shows that zinc sheet exposed to artificial sea-water maintained at 60°C. for two weeks lost 10 m.g. per sq. in. The percentage loss of metal was 1.3. A piece of steel, zinc-sprayed on both sides, treated similarly, gained in weight, in spite of extravagant washing, because of corrosion product held in the porous sponge beyond the reach of the washing water. It was concluded that in two weeks more than 6.7 per cent of the metallic zinc had changed, presumably into zinc chloride or zinc oxychloride mostly held in the pores of the coating—an amount at least five times that lost by the zinc sheet. No doubt this was because of the large surface

area exposed per unit mass. It is fair to suggest that a similar picture would obtain for sulphates from atmospheric pollution, and, broadly speaking, that sort of thing is the justification for painting.

It is generally agreed that aluminium metal is more resistant than is zinc to the forms of attack discussed, but there is some uncertainty about the sacrificial protective qualities of aluminium even under good conditions. I gather that there is much difference of opinion about the manner of the protection afforded by aluminium, the effects of its oxides—and, for that matter, those of iron—and whether the oxide films are insulating, or possibly semi-conductors—which brings into question whether there is good metal-to-metal contact—and what effect they have on the cathodic and sacrificial protection, if any, given, at any rate, by aluminium.

We, as paint technologists, do not mind very much how the argument goes, but we tend to think that it is a good idea to keep the sacrificial non-ferrous lamb from the altar, anyway, and we know that aluminium-sprayed steel can yield rust stains—apparently without too much effort on the part of the attacking forces. In time, of course, the corrosion products fill the pores, the corrosion process may be stifled, but not wholly stopped, and there may be an unsightly appearance—all for the want of a coat of paint. In this connexion, I think that it is acceptable as the basis of any argument that if you kill the sacrificial lamb, it is dead. The thing to do, therefore, is to keep it in reserve. Broadly, in developing views about painting, we argue that what is good enough for zinc will be good enough for aluminium, so that one scheme will do for both situations.

As to the type of paint, there are some people, including paint manufacturers, who hold the view that no special types are necessary. We have doubted that, and note with some satisfaction that, according to the literature, other people in various parts of the world have doubted it also. It was for long suggested that a zinc chromate primer—well known for its successful history on non-ferrous metals in the massive form—was adequate and suitable for metal-sprayed coatings. We do not believe that ordinary pigmented systems are the most suitable, because sprayed metals can be reasonably efficient filters, as shown by our experiments with Perspex and glass, and, as a result, there is a tendency for relatively underbound pigment to lie at, or near, the surface of the sprayed metal structure. This deficiency may be made good from succeeding coats—but there may be no succeeding coats. On the whole, I think that the idea is not a good one.

I mentioned earlier that zinc has a poor reputation as a painting prospect. That is true in the massive form, using conventional materials, from boiled

oil to alkyds which depend for drying upon oxidation, whereby low molecular weight fatty acids and chemically active scission products are formed that can produce a variety of undesirable compounds at the zinc interface. One such is formic acid resulting in zinc formate crystals, as can be seen and identified under a microscope. None of these things helps adhesion and, in a broad sense, they can be said to stimulate corrosion. Therefore, in general terms, the attitude to the painting of massive zinc is to control the surface reactions. Out of that idea came the idea of using a mordant, and the more recent idea of etch primers—the phosphoric compounds of chromium and phosphorus in the organic system.

Generally speaking, therefore, I suggest that we should edge away from oxidation systems. That means looking at a variety of polymeric materials such as polystyrene, chlorinated rubber, isomerized rubber, polyvinyl acetate and a variety of copolymers, some of which can be applied in emulsion as well as in the spirituous form; and some special types such as etch primers—and even polyurethane condensation products, which need neither spirit nor water to get them into position. However, it is a little early to consider the polyurethanes, excellent as they are, as a practical proposition, on account of difficulties of application.

We started experimenting in this direction early in 1955, and the first results indicated that, under our ordinary methods of test for performance—in so far as they could be applied—everything tested did quite well, and mostly rather better than had been expected. Such differences as were noted were relatively small and inconsistent. The answer is obvious, and simple. Only a fraction of the material applied to satisfy the porosity of the sprayed metal had any air surface and, therefore, the attack of the weathering agents was limited. By and large, the paint was as well protected in the porous structure as if it had remained in the tin.

Actually, we have found some difficulty in bringing the complete systems to breakdown except after a very long time. The accelerated weathering required from 6,000 to 12,000 hours—which is a very long time, indeed, for such a test. Nevertheless, the tests have been adequate to support our appreciation of the requirements of the painting system, and the physical and chemical status of the surfaces achieved.

The sprayed metal used for test was either two or four-thousandths of an inch thick. It was filled by brush application and tested as sprayed, and then again after being painted. In one early case, an undercoating and finishing coat in light battleship grey was given, following a practical failure by heavy chalking, in which we were interested at the time, but mostly the finish given was

one coat of the simplest type of linseed oil paint.

By and large, the filling materials used were: polystyrene, aluminium isopropoxide in xylene; chlorinated rubber; etch primer based on polymer; P.V.A. solution; polystyrene emulsion; P.V.A. emulsion, and silicones. Over them was then applied one coat of the simplest metal paint as an indicator.

These were examined first without benefit of finishing coat, however, and after two weeks on aluminium, under accelerated weathering, panels Nos. 2 and 6 were showing brown iron stains or dark patches, as were the control panels. After five weeks, both panels were removed from the test. The remaining coatings were placed in the following order:—the best first: polystyrene; etch primer; P.V.A. solution; chlorinated rubber and P.V.A. emulsion. After seven weeks, the control panels showed signs of considerable steel corrosion, and were more or less covered with gelatinous corrosion product. After nine weeks, the etch primer and the chlorinated rubber were clearly the survivors.

On zinc, much the same results were observed, with more blistering and general disturbance and in rather shorter time, except that the aluminium isopropoxide did much better. The survivors, after five weeks, were etch primer and chlorinated rubber, as before.

Under the standard salt-spray test on aluminium the only fillings which seemed to be undisturbed were the silicone and the etch primer. For one reason or another, all the others failed.

On the zinc oxide, we noticed how much better aluminium isopropoxide behaved, but it still washed out in large measure. But it looked as if it might do well under a finishing coat. It is interesting to note that the Shell Company in 1952 filed a patent covering the use of aluminium alcoholates for this very purpose. The surviving panels, after four weeks, carried silicone, polystyrene solution and etch primer. Putting the two sets of test panels together, it looked as if the prospects were silicone, chlorinated rubber and etch primer.

At this stage, we added isomerized rubber, which we went to because it is highly penetrating, and also in view of the promising performance of chlorinated rubber; and this is when the resistance to testing leaped into very high figures indeed. Even the aluminium isopropoxide filler on zinc was quite sound, and the finishing paint film intact after 12,000 hours. The system was somewhat less satisfactory on aluminium. The silicone filler did not hold the finish coat well, neither did the polystyrene. The isomerized rubber was even better than the chlorinated rubber and, as before, the winners were chlorinated rubber, isomerized rubber and the etch primer, particularly so as in this series of experiments the phosphoric

acid content of the etch primer had been reduced and its traditional polyvinyl butyral composition modified by the addition of phenolic resin.

Many such panels have been tested over a long period but, more important, the idea has had substantial practical and successful application. I have in mind the fact—and I do not think that it is particularly secret—that some years ago now a British firm had the contract for two bridges in Australia, involving, if memory serves, some 20,000 tons of steel. I was called in to advise on the matter, and as a result of my advice, which, presumably, was accepted, the job was done with etch primer very conveniently arranged in line ahead with the metal spray, which was partly zinc and partly aluminium.

The steel, so treated, withstood the vagaries of handling and sea transport to Australia, and the various reports that have since reached me all confirm the complete satisfaction given by the job, which is considered to have been well worth the extra cost. I believe that after erection the steel was given one coat of aluminium varnish—though I am not sure of the details—and very little maintenance cost is expected. It is that that matters. Records of parallel shipments of sprayed steel without such protection have shown, shall I say, profound disappointment—to put it gently. There is no doubt that the cost of full and proper treatment is not enough to justify placing the performance of this class of steel structure in jeopardy.

So far as I know, the largest metal-spraying job yet done in Great Britain was at the Abbey Steel Works, at Margam, South Wales, where every structure above crane level was given 0.004 in. of sprayed aluminium. This was followed by an aluminium paint coat and, again, I understand, that in eleven or twelve years the maintenance repainting has been extremely light.

Only one thing I must make clear. The suggestion that the application of an etch primer to either a zinc or an aluminium spray coating on steel is the ideal treatment relates in my experience, only to an ideal procedure; that is to say, one in which the steel parts are shot blasted, metal sprayed and treated with etch primer in quick succession. What would be the best procedure to follow with erected structures which most probably have suffered some unpleasant exposure, I am not prepared to discuss now. Unfortunately, and quite recently, important structures have been metal sprayed, and left. I would suggest to the spraying community that they should use their influence all the time to see that these things do not happen, because, surely, the extra maintenance will not only be tiresome but costly.

I have mentioned the phosphoric acid, and its reduction in the etch primer. I can well under-

stand that there may be some little uncertainty about the desirability of having phosphoric acid. None the less, the whole process as it emerges satisfies the surface activity in a controlled manner—that is to say, a new, highly-complex film containing chromate and phosphate is laid down on the metal—and if there is phosphoric acid it does not appear to be aggressive, or, to put it another way, we have seen no evidence of such aggression if only the minimum amount of phosphoric acid required to make the system effective is used. Reports from American workers on related matters suggest that etch primer is a good starting material provided that the phosphoric acid does not exceed 4 per cent so as to restrain attack on the sponge. Actually, we find it necessary to go a little higher—about 5½ per cent of phosphoric acid—which is substantially below the normal butyral requirement. Also, butyral is not the only remaining material that can be used. I have indicated the conjunction with phenol, and one can also use shellac as the basis. One important feature of our recommendation is that the solids content of our phenolic modified system is higher than that of wholly butyral material, and it therefore has more filling or sealing capacity. Another point is that if sprayed metal should get wet, the etch primer will take care of it, but the organic primers might well be rejected by the moisture. Finally, once the sponge has been treated with etch primer or filled with non-reactive polymer, any decorative scheme of painting can be used.

DISCUSSION

Mr. F. A. RIVETT (Member of Council) asked about porosity tests. His own staff had done many such tests—metal penetration tests, comparisons of the density of the sprayed metal and so on—and had obtained figures for the “voids” ranging between 10 per cent and 15 per cent as had been mentioned by Dr. Hoar. Apparently Dr. Jordan regarded porosity as a virtue, in the sense that it kept the paint in good condition.

Mr. Rivett thought that it would be generally agreed that metal-sprayed coatings should be painted; when work had been left unpainted it had, in general, been against the advice of the metal-spraying company unless the conditions of use involved higher temperatures than paint could be expected to stand.

He also thought that the time had nearly come when some big-scale work would be done with the 50-50 zinc-aluminium coatings, although he did not know whether the procedure outlined by Dr. Jordan would apply equally to those coatings.

Dr. JORDAN replied that the suggestion of using zinc-aluminium was very sound, and Dr. Hoar was to be congratulated on having put it forward. It was unlikely that anyone considering the painting situation would be worried about the composition of the alloy.

Mr. RUDRAM, also replying, said that he had done some porosity experiments, though probably not on the same lines as those mentioned by Mr. Rivett. He had been mainly concerned with sealing the metal coatings ready for the decorative coating, and obviously the surface metal was flooded with the filling materials used. They certainly penetrated very well and on this basis the calculation of the voids filled came out at 70 per cent and more—as much as 80 per cent on some aluminium panels. Such high figures might appear to be remarkable but no matter what penetrating material was used to fill the sponge, the results were always much the same.

The CHAIRMAN, Mr. H. W. Fender (Prodorite Ltd.) (Chairman of the Association) remarked on the reference in the paper to polyurethanes. He described the results obtained with them as encouraging.

Dr. JORDAN said that he was interested to hear about Mr. Fender's experience in the use of such materials, for it was an aspect of paint technology that was rapidly advancing. There was a move away from organic solvents and thinners in paint (because such things constituted a fire risk and were rather expensive) towards water dilution and emulsion techniques or to materials that required no dilution and did not eliminate anything on drying. That was the basis of the use of the polyurethanes which were being applied very successfully to furniture treatments, for example, but considerable care in application was necessary because of the toxicity of the isocyanates required.

The CHAIRMAN added that the toxicity had been considerably reduced as a result of German research.

Mr. KERENSKY (Freeman, Fox & Partners) asked Dr. Jordan what he recommended as the minimum thickness of the metallized surface for long life steelwork before applying the best protection possible? Second, what was the life of the recommended primers—the etch primer and the isomerized rubber; how long could the work be left unpainted before applying the finishing coats? Third, what primers did Dr. Jordan recommend on steelwork for export and for use at home?

Dr. JORDAN replied that metal sprayers generally regarded four-thousandths of an inch of metal spray as satisfactory. In more general

terms, the thicker the better, but the thickness had to be related, in terms of cost, to the life factor. The Research Association had experimented mainly with the four-thousandths and the two-thousandths of an inch thicknesses, and had found that, on small panels, the difference in behaviour had not been very great. Nevertheless, he would feel just a little uneasy in recommending anything less than the four-thousandths of an inch thickness. On the other hand, if the metal-sprayed surface is painted need the thickness be so great?

Mr. KERENSKY said that 0.002-in. thickness was allowed by Bridge standards.

Dr. JORDAN, continuing, said that he had already indicated that the sponge was of such a nature that the filling material did not expose very much surface so that it was reasonable to expect a long life even under adverse conditions. He saw no reason why a good well sprayed metal coating—say, four-thousandths of an inch thick—well filled, and then paint protected and well maintained, should not last for almost as long as the life of the steel structure itself. He thought that Dr. Hoar would probably agree with this generalized summary.

The question of painting and the filling of the voids in the manner indicated is mixed up with the problem whether or not one can take liberties with metal-sprayed steel by leaving it unpainted after filling the voids, and that was the whole basis of the etch primer used on the steel that was sent to Australia. The filling with the etch primer was well done and gave a very considerable facility in transit and during construction.

Mr. DOOR (British Petroleum Ltd.) asked for Dr. Jordan's views on the use of an oil-bound primer pigmented with calcium plumbate on zinc metal spray. He himself was attracted to it as the calcium plumbate seemed to have good adhesion to the zinc.

Dr. JORDAN agreed that the adhesion of calcium plumbate/oil paints to massive zinc was good and offered a first-class painting prospect.

Dr. HOAR asked whether it was a good idea to include a proportion of say zinc oxide as a reserve of basicity to take care of any acid there might be in the primer or formed during oxidation of the medium used.

Dr. JORDAN agreed that such "dodges" were effective for a comparatively short time. A parallel situation often arose with ultramarine—a very nice blue pigment but, unfortunately, sensitive to acid. The life of such compositions could be increased by adding basic components like barium carbonate, but they could not stop the colour going sooner or later.

(Report to be concluded)

ZINC COATINGS ON IRON AND STEEL

2 - Methods of Applying Zinc Coatings to Iron and Steel Surfaces

A Survey

by A. K. PARKER, M.A.

in collaboration with the Zinc Development Association

(Continued from page 245, June 1959 issue)

FIVE methods of applying a zinc coating to iron and steel are in general use, *viz.*: hot-dip galvanizing, zinc spraying, zinc plating, sherardizing and painting with zinc-rich paints. This chapter contains a brief description of each process, the nature of the coating formed by it and its practical advantages and limitations. It will be seen that, while there is always at least one process applicable to any particular set of practical circumstances, the processes are complementary rather than competitive so that there are rarely more than two processes to be seriously considered as the best choice for a particular job.

HOT-DIP GALVANIZING

In hot-dip galvanizing, the article to be zinc coated is completely immersed in a bath of molten zinc. It is by far the most widely used of the zinc coating processes and has been practised commercially for almost two centuries. The first report on it was made in 1741 by the French chemist Melouin⁽¹⁾; the name galvanizing⁽²⁾ came later, probably being derived from the minute galvanic currents (first observed by the Italian physiologist, Luigi Galvani) which prevent exposed parts of the underlying iron from rusting at gaps in a zinc coating. The modern hot-dip galvanizing process, carried out in carefully controlled plants applying the results of scientific research, is far removed from that of fifty or more years ago, though still dependent on the same basic principles.

The process is applied to finished articles and also to semi-fabricated materials—sheet, strip, wire and tube. There is an obvious advantage in galvanizing after fabrication in that the zinc completely seals edges, rivets and welds, so that there are no uncovered parts from which rusting can start.

The Galvanizing Process

Before the iron or steel are dipped in the molten zinc, it is first necessary to remove all scale and rust from its surface. This is usually done by pickling in dilute acid; either sulphuric or hydrochloric acid or a mixture of the two may be used. To remove moulding sand and surface graphite from

iron castings, shot blasting is generally adopted, sometimes followed by a brief pickling operation; shot blasting is described in more detail in the section on zinc spraying (page 316) for which it is the normal method of surface preparation. In the Sendzimir type of process for the continuous galvanizing of steel strip, a heat treatment in cracked ammonia is used instead.

The ordinary pickling process leaves a film of dissolved iron salts on the surface of the iron or steel. Whether these are washed off the surface or not depends on which of the four basic galvanizing techniques is being used.* In the modern dry galvanizing process, the salts are invariably washed away and the work dipped in a flux solution of zinc ammonium chloride, whence it is passed to a low-temperature drying oven. It is then ready for dipping into the molten zinc bath, the surface of which is kept relatively clear of flux.

In wet galvanizing, on the other hand, the pickled articles are dipped into the molten zinc bath through a substantial flux blanket. The iron salts are sometimes left on the surface of the work, though this practice is not to be recommended.

In all processes, as the work enters the bath the protective layer which has prevented oxidation of the freshly pickled surface peels off and the work is immediately wetted by the molten zinc. This involves inter-penetration of the iron and zinc with the formation of alloy layers.

The old-fashioned type of galvanizing bath heated by coke fires around the sides has now been largely replaced by designs susceptible to close thermostatic control. In some of these, hot gases are circulated around the sides of the bath; in others, direct gas or electric heating systems are employed. The usual operating temperature is from 445–460°C.

Nails and other small articles which do not need a particularly fine finish are often zinc coated by flake galvanizing. In this, granulated zinc is melted in contact with the nails etc. in a heated rotating drum for about 5–10 minutes.

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Fig. 4.—Gas-fired furnace for galvanizing window frames; the pot is 9-ft. deep.

(Courtesy Zinc Development Association)



Nature of the Hot-dip Galvanized Coating

Fig. 5 is a photo-micrograph of a typical hot-dip galvanized coating. It will be seen that the coating consists of a series of layers. Starting from the basis steel at the bottom of the section, each successive layer contains a higher proportion of zinc until the outer layer, which is relatively pure zinc, is reached. There is therefore no real line of demarcation between the iron and the zinc, but a gradual transition through the series of iron-zinc alloys which provide a powerful bond between the basis metal and the coating.

The structure of the coating, *e.g.* the number and extent of the alloy layers, and its thickness

depend on the composition and physical condition of the steel being treated⁽³⁾ as well as on a number of factors within the control of the galvanizer. For example, heavier coatings tend to be deposited on rough-surfaced and coarse-grained steel⁽⁴⁾ and, at the same time, the total thickness of the alloy layers tends to be slightly greater at corners than at hollows⁽⁵⁾.

The total thickness of the coating may be controlled by varying the time for which the work is immersed in the molten zinc and the speed at which it is removed⁽⁶⁾. If only a thin coating is required, as is sometimes the case in sheet or wire galvanizing, the work is mechanically wiped on

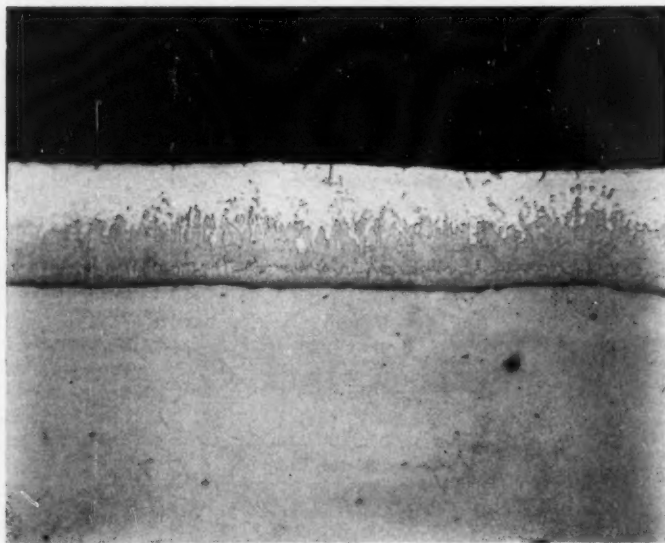


Fig. 5.—Photomicrograph of a section through a typical hot-dip galvanizing coating.

(Courtesy British Non-Ferrous Metals Research Association)

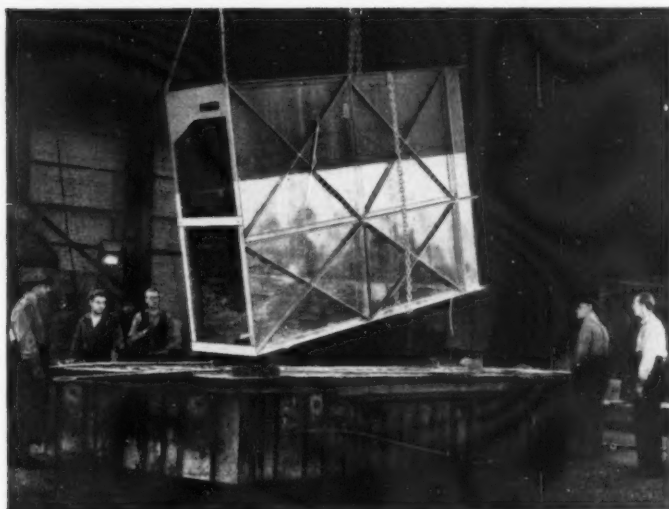


Fig. 6.—Galvanizing a degreasing tank—the first dip completed.

(Courtesy Zinc Development Association)

being withdrawn from the bath in order to remove excess zinc. The temperature of the bath has little effect on the nature of the coating provided it is kept between 430 and 470°C.⁽⁵⁾

The ratio of the total thickness of the alloy layers to that of the outer zinc coating is also affected by varying the time of immersion and the speed of withdrawal of the work from the molten zinc bath⁽⁷⁾; the rate of cooling of the steel after withdrawal is another factor to be taken into account. Sheet galvanizers operating continuous strip processes usually suppress the formation of alloy layers by adding 0.1 to 0.2 per cent aluminium to the bath⁽⁸⁾; this increases the ductility of the coating and so makes the sheet more amenable to fabrication.

Other elements may be added to galvanizing baths to improve the characteristics and appearance of the coating. Tin and antimony give rise to well-defined spangle effects, while the presence of some lead in the bath is generally considered desirable. Aluminium also improves the appearance of the coating.

Advantages and Limitations of the Process

An important advantage of the hot-dip galvanizing process is that, unless zinc is removed by mechanical devices (a practice confined to the specialist galvanizing of sheet, strip, wire and tube), the work is bound to be thoroughly covered and to carry a thick coating usually weighing from 1.8 to 2.2 oz. of zinc per sq. ft. of surface.* All edges, rivets, seams and welds are thus sealed by the hot-dip process. Furthermore, it will often

be found to be the most economical process where large amounts of steel require to be treated.

The size of galvanizing baths does of course limit the size of articles which may be treated, but by suitable double-dipping it is possible to protect surprisingly large articles in this way (see Fig. 6).

Heating fabricated articles to 450°C. by immersion in molten zinc baths occasionally has undesirable effects but these can usually be overcome. For instance, warping can be eliminated by paying careful attention to welding techniques so as to balance stresses. Possible embrittlement of Blackheart malleable cast iron, which is only likely if its phosphorus content exceeds 0.07 per cent, can be avoided by quenching in water from 650°C. before galvanizing⁽⁹⁾. The danger of embrittlement in galvanizing articles which have previously undergone severe localized cold working can be overcome by suitable stress relieving (see Chapter 5).

ZINC SPRAYING

Zinc spraying consists in projecting "atomized" particles of molten zinc on to a prepared surface. It owes its origin to the experiments of Dr. M. U. Schoop of Zurich, about 1909, and has since been developed rapidly, especially in Great Britain which is now said to make greater use of metal-spraying equipment per head of the population than any other country in the world⁽¹⁰⁾. Three types of pistol are in commercial use in Great Britain today; viz.: the molten metal pistol, the powder pistol and the wire pistol.

Surface Preparation

The surface preparation of the work is the same for each process and involves cleaning and then

*It should be noted that whereas sheet galvanizers quote the weight of zinc per sq. ft. of sheet, which is twice the weight on each sq. ft. of surface, all other galvanizers quote the weight on each sq. ft. of surface, as is the practice throughout these articles.

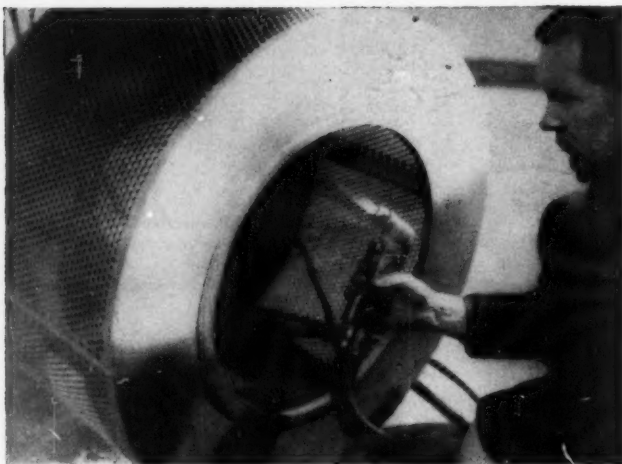


Fig. 7.—Zinc spraying a centrifuge basket by the powder process.

(Courtesy Schori Division, F. W. Berk and Co. Ltd.)

roughening the surface to be sprayed. The usual method of roughening is to blast the surface with an abrasive driven either by a stream of compressed air or by a centrifugal device such as a Wheelabrator. The most suitable abrasive is clean and reasonably sharp angular steel grit although it may be necessary to use alumina or similar hard abrasive where the hardness of the underlying metal exceeds about 350 D.P.N.; the abrasive should be renewed when it becomes rounded. It is not always possible to salvage the used abrasive and so flint sand is sometimes used out of doors where the silicosis risk is small.*

Whatever method of surface preparation is used, it is important that the sprayed zinc coating should be applied as soon as possible after the surface has been prepared in order to reduce the possibility of oxidation and so increase the effectiveness of the metal-to-metal bond. B.S. 2569, Part 1, 1955 specifies that "if, on comparison with a freshly prepared surface, visible deterioration has occurred, then the surface preparation should be repeated"⁽¹¹⁾. The time lag is reduced to a minimum in the mechanized plants which have been built for production line work and for treating constructional steelwork prior to assembly.

The Three Methods of Spraying Zinc

In their present state of development, the three methods of spraying zinc give coatings of comparable quality. Each technique uses zinc of different physical form and the processes will therefore be described separately:

(a) The Molten Metal Process

Molten zinc, usually held in a gas-heated graphite

crucible, is transferred to a heated container in the pistol. The molten metal is gravity-fed to the spraying nozzle and ejected from it by a stream of preheated compressed air issuing from a hollow annular ring surrounding the nozzle. The container, which in one type of pistol holds 4 lb. of molten zinc, requires replenishing every 20 minutes or so.

The method possesses the advantage of simplicity as the only supplies it requires are town's gas at mains pressure and compressed air. As the zinc is used in ingot form, the raw material is the cheapest possible. On the other hand, the pistol tends to be rather bulky and the nozzle needs to be replaced every hour or so, although this is a very simple operation. Owing to the gravity metal feed, a special type of pistol is required for vertical spraying.

(b) The Powder Process

In this process zinc particles are suspended in a gaseous medium and driven through a blowpipe flame. It is essential that the particle size of the zinc powder should fall within certain limits; B.S. 2569 specifies that 99.9 per cent of the powder should pass through a 100-mesh test sieve and that over 30 per cent should be retained on a 300-mesh test sieve.

The stream of powder-laden gas is heated by a blowpipe flame surrounding the nozzle and outside this a cone of compressed air gives impetus to the stream of molten droplets. In the older types of equipment, the powder, entrained in an air stream, was sucked into the pistol by the creation of a partial vacuum in the pistol head. Recently an improved type of apparatus has been developed in which the powder is fed under pressure, without compacting, in any desired conveying gas⁽¹²⁾; it is claimed that this gives an improved coating on

*A portable apparatus known as the 'Vacu-Blast' can be used to collect the particles by suction immediately after they have done their work.

account of the greater heating capacity of the flame and the reduction of oxidation resulting from the use of a non-oxidising gas to convey the powder particles.

It will be seen that there are four feeds to the pistol, these being combustible gas, oxygen, compressed air and zinc powder suspended in air or a gas. A wide choice of fuel gases is available since the gas does not have to function as an atomizer.*

(c) The Wire Process

Zinc wire is fed axially into the centre of a blowpipe flame issuing from a ring of small gas ports. A stream of compressed air disintegrates the film of molten metal as it forms and sprays it out of the nozzle. The oxygen and fuel gas supplies for the blowpipe flame are at the same pressure so that they may be simply mixed in a small chamber.

In hand tools, such as are used for zinc coatings, a compressed air turbine is used to drive the wire feed through worm reduction gearing. Nozzles often consist of a sleeve of hard steel surrounded by copper to disperse the heat generated by the blow-pipe flame.

Various types of wire spraying pistol have been developed abroad in which electricity is used in place of gas for heating, but these have not found favour in Great Britain as they are said to be difficult to control and to require the use of heavy direct currents.

The Nature of the Sprayed Zinc Coating

The sprayed coating is slightly rough and slightly porous, the specific gravity of a typical zinc coating being about 6.35, as compared with 7.1 for cast zinc. This slight porosity does not affect the protective value of the coating because the zinc is anodic to steel as explained in Chapter 1; the zinc corrosion products which form when the coating is in service fill up the pores to give a solid coating. The slight roughness of the surface makes it an ideal basis for paint.

The mechanism by which the zinc adheres to the underlying surface has been the subject of much experiment and speculation but there still remain many divergent views about it. Although no alloy layer is formed and the bond is purely mechanical, the adhesion of zinc to a properly prepared iron or steel surface is extremely powerful. Recently, it has been suggested that pre-heating the basis metal gives even greater values for adhesion⁽¹²⁾. In the ordinary process, the impact of the particles of molten zinc on the surface causes only a very slight rise in temperature of the basis metal.

Advantages and Limitations of the Process

Zinc spraying has the big advantage over most other methods of zinc coating that it can be applied on the site to work of almost any shape or size. When applied to finished articles, welds, ends and rivets receive adequate coverage. Moreover, it is the only satisfactory method of depositing unusually heavy zinc coatings, of the order of 0.01 in. and greater.

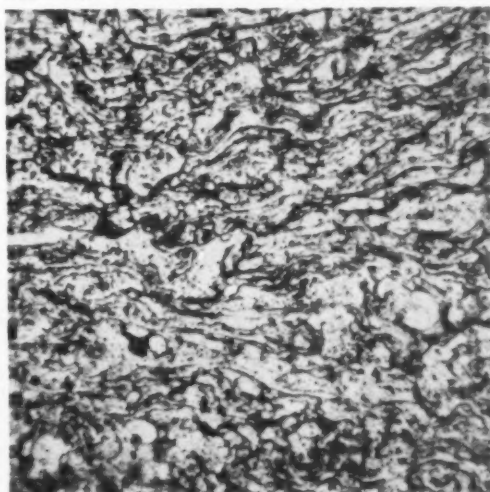
Zinc spraying is not normally suitable for depositing coatings inside cavities etc., though special types of nozzle are available for applying coatings inside short lengths of tube. The process is seldom economical for treating "open" structures such as wire mesh because of the large wastage of metal which would result.

The mechanized plants, such as those used for treating constructional steelwork prior to assembly, make it possible to deposit extremely uniform coatings. In hand spraying, the degree of uniformity achieved depends entirely on the skill of the operator.

ZINC PLATING

Coatings of zinc may also be applied to iron and steel surfaces by electroplating, the article to be plated being made the negative electrode in an electrolytic cell containing a solution of a zinc salt through which an externally-generated current is passed. Zinc is supplied to the cell either as the expendable positive electrodes or as zinc salts added direct to the plating solution. Zinc plating is sometimes called electrogalvanizing.

Fig. 8.—Photomicrograph of a sprayed zinc coating ($\times 250$, etched 2 per cent nital). (Courtesy Metallisation Ltd.)



*For a comparison of fuel gases, see W. McDermott and R. Dickenson. *Engineer* 196 (1953) pp. 6-9.

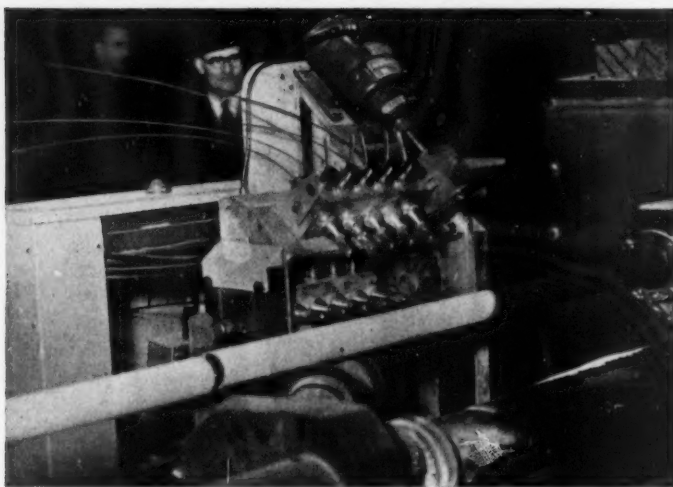


Fig. 9.—A machine specially designed for zinc spraying tubes. Machines similar to this one have been designed to take tubes from 1 to 6-in. bore. Production speed for a 2-in. tube would be at the rate of 20-ft. per minute when applying a 0.004-in. coating.

(Courtesy Metallisation Ltd.)

Surface Preparation

The adherence of electrodeposited zinc coatings depends on the metal-to-metal bond between the plated coating and the underlying steel surface. For this reason, particular attention must be given to the preparation of the surface before plating, so as to obtain a coating in true physical contact with the whole of the steel surface.

The usual method of removing all rust, scale and grease from the steel surface is by acid pickling, sometimes preceded by alkaline degreasing. Adequate rinsing between each stage of the cleaning process is essential, particularly if inhibitors are present in the pickling bath.

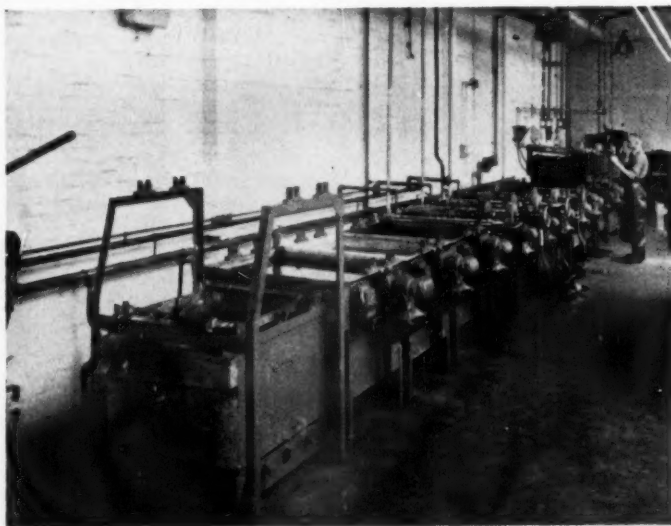
Zinc-Plating Baths

Most zinc-plating baths contain either acid sulphate solutions or alkaline cyanide solutions. The cyanide baths have a higher throwing power,* which makes it easier to deposit uniform coatings on relatively complex shapes. On the other hand, acid baths deposit satisfactory coatings somewhat more rapidly than cyanide baths and are much easier to use when plating on cast iron or iron-powder parts.

*Because the electric current tends to follow the shortest paths between the anodes and the article, the coating does not build up uniformly but tends to be thickest on those parts of the article which are nearest to the anodes. The ability of plating baths to deposit metal in recesses and on parts of the article furthest from the anodes is termed 'throwing power.'

Fig. 10.—Plant for zinc plating small parts in barrels.

(Courtesy W. Canning and Co. Ltd.)



Small articles are barrel plated in zinc-cyanide baths, a large number of the articles being placed in a suitably constructed rotating barrel immersed in, or containing, the plating solution.

Modified acid baths are used for the continuous electrogalvanizing of strip and wire. The Tainton Process⁽¹³⁾ uses a strongly acid solution of zinc sulphate in conjunction with insoluble anodes of a silver-lead alloy and a very high current density.

Various brightening agents⁽¹⁴⁾ may be added to cyanide baths to give a deposit which is more lustrous than that obtained from normal zinc-plating baths. The amount of brightening agent requires very careful control and both the bath and the zinc anode must be kept particularly pure when brighteners are used. Mercury was formerly used as a brightening agent but its use has now been largely discontinued because occasional trouble was experienced with "sweating" and black spots on the surface of the coating.

Other zinc-plating baths have been reported in the literature⁽¹⁵⁾ but do not appear to be established commercially.

Nature of the Zinc-plated Coating

The normal zinc-plated coating is dull grey in colour with a matt finish but, as has already been mentioned, whiter and more lustrous deposits can be produced by the use of special addition agents. The coating consists of pure zinc and is of uniform composition throughout. It adheres by means of metal-to-metal bonds which rely for their strength on the coating conforming very accurately to the underlying steel surface.

Advantages and Disadvantages of the Process

Electrogalvanizing is the most precise of all zinc coating processes and so is particularly suitable for coating delicate articles, such as instrument parts, on which a fine finish is essential. Furthermore, the articles need never be heated to a temperature above the boiling point of water.

The pure zinc coating is extremely ductile so that it is quite easy to form zinc-plated sheet without damaging the coating.

On simply shaped articles, it is possible to control the thickness of zinc-plated coatings within fine limits but, as the throwing power of zinc baths is not very high, articles with deep recesses can only be plated with difficulty. Barrel-plated articles have coatings rather more uniform in thickness than those normally obtained.

Zinc electrodeposits expand very slightly during plating⁽¹⁶⁾ so that, if the deposit does not adhere properly, blistering may develop. The effect develops slowly, taking several hours or even days for completion; it is most marked in acid-sulphate deposits.

Electrogalvanizing is not suitable for applying

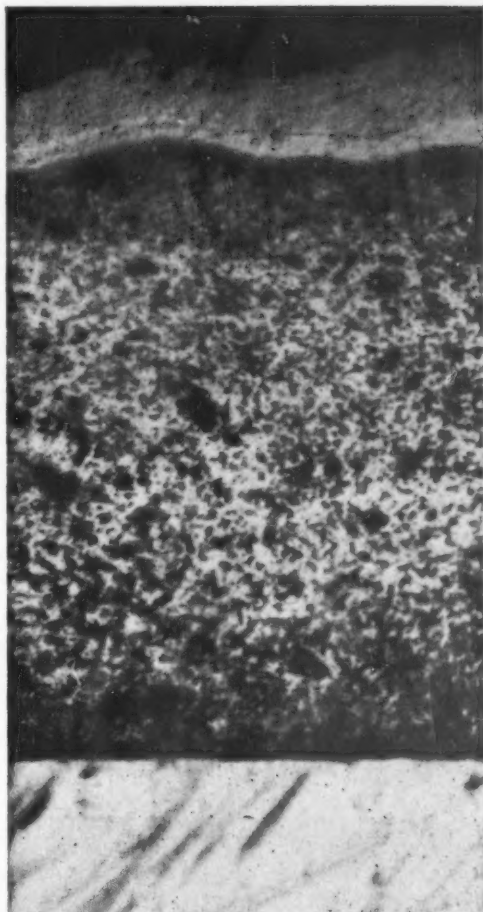


Fig. 11.—Photomicrograph of section through an electro-deposited zinc coating on steel (a 1000).

(Courtesy W. Canning and Co. Ltd.)

very heavy zinc coatings and is usually confined to depositing coatings having thicknesses in the range 0.0002 to 0.001 in.*

SHERARDIZING

Sherardizing is a cementation process in which zinc is made to combine with an iron or steel surface by heating the work with zinc dust at a temperature slightly below the melting point of zinc. The process takes its name from that of its British inventor, Sherard Cowper-Coles, who first patented it in 1901⁽¹⁷⁾. It is perhaps the least known of the methods for applying a zinc coating

*B.S. 1706 : 1951 specifies coatings with minimum local thicknesses of 0.001, 0.0003 and 0.0002 in. and corresponding average thicknesses of 0.0015, 0.0005 and 0.00035 in.

to iron or steel and the published literature on it is very sparse.

The Sherardizing Process

It is first essential to remove all scale, rust and impurities from the surface of the work. This is done either by acid pickling or by shot-blasting, preceded if necessary by solvent or vapour degreasing. The pickling cycle is similar to that applied to articles to be hot-dip galvanized. Finally the work must be dried thoroughly; this is important as otherwise hydrogen may be formed when the work is heated with zinc dust and an explosion result. Shot-blasting is used instead of acid pickling to prepare castings, spring steel, welded and brazed assemblies and other work liable to retain acid salts, with a consequent risk of their causing local rusting.

The work is then placed in mild-steel drums with a carefully calculated quantity of zinc dust and the lids fastened. The drums are placed in a furnace, the temperature of which is accurately maintained at a predetermined level (usually about 380°C.) for several hours. During this time the drums are rotated slowly in order to renew continually the layer of zinc dust in immediate contact with the work. Roughly speaking, about 1 oz. of zinc dust is allowed for each square foot of surface to be treated, an inert substance such as sand, olivine or alumina being added to assist the even distribution of the zinc dust.

The process is continued until it is calculated that a coating of the required thickness has been obtained. The drums are then cooled and their

contents extracted, the work being separated from the residual zinc dust and inert material, either by hand or by sieving.

The Nature of the Sherardized Coating

A sherardized coating has a matt grey appearance and is extremely uniform in thickness. It consists almost entirely of iron-zinc alloys, a typical coating containing 8-9 per cent iron; consequently it is very hard. Interaction between the zinc dust and the work seems to proceed by diffusion at the points of contact. Probably, the iron diffuses into the zinc rather than the reverse, the crystal lattice of the zinc being disrupted at the sherardizing temperature which is only a little below the melting point of zinc.

However, there appears to be no recent published work on the structure of sherardized coatings comparable with that dealing with other types of zinc coating.

Advantages and Limitations of the Process

The uniformity of the sherardized coating makes it an excellent process for treating parts which are subject to close tolerances or which contain deep recesses. Provided proper allowance is made for the dimensional increase when the parts are designed, screw threads may be zinc coated by sherardizing without the need for subsequent tapping or other after-treatment. Again, the insides of tubes and other hollow articles receive a coating comparable in quality with that on the outside.

Because they consist mainly of iron-zinc alloy,

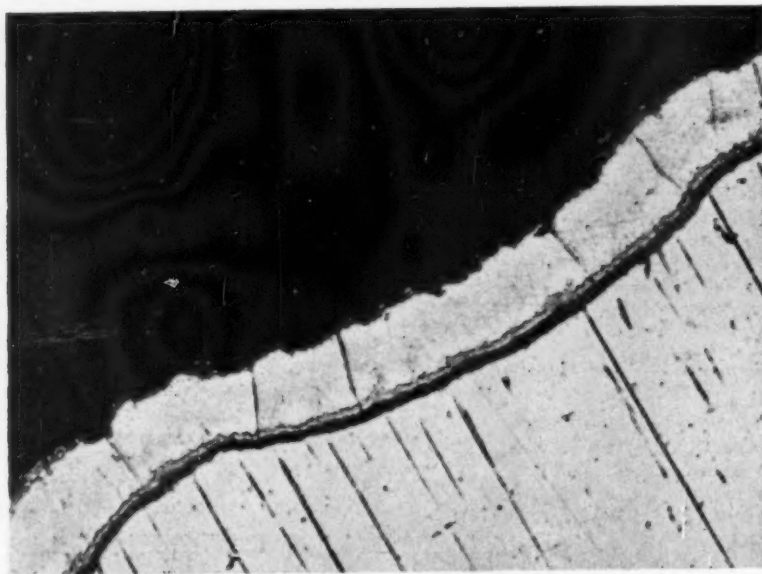


Fig. 12.—Photomicrograph of a section through a sherardized coating showing how closely it follows the contour of the steel base. (Courtesy Zinc Alloy Rust-proof Co. Ltd.)

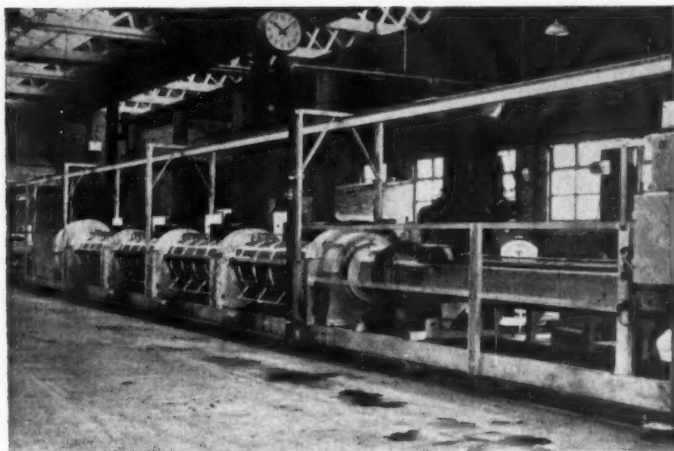


Fig. 13.—Continuous Sherardizing furnace, through which the parts to be zinc coated are passed in perforated steel boxes.

(Courtesy Zinc Alloy Rustproof Co. Ltd.)

sherardized coatings are harder and possess a higher resistance to abrasion than do other zinc coatings. They can be painted without any pretreatment.

The maximum size of articles which can be sherardized is limited to the size of drums available. Most of these are about 6 feet long with a width of rather less than 2 feet, though narrower ones up to 20 feet long are also in use. In general, it is true to say that the process is best suited to the treatment of small castings, forgings and pressings such as woodscrews, nuts, bolts, washers, chains, springs etc., having particular advantages where close tolerances are required.

There is a limit, too, to the thickness of zinc coating which may be applied by sherardizing and it is rare for the process to be used to deposit coatings of more than 1 oz. zinc per sq. ft., the

minimum coating being about $\frac{1}{2}$ oz. per sq. ft.

Because a sherardized coating is an alloy of iron and zinc, it sometimes appears brownish in colour when it has been in service for a short while. This does not mean that the coating is beginning to fail but it may make a sherardized finish unsuitable for parts which have an ornamental value.

PAINTING WITH ZINC-RICH PAINTS

In recent years, a number of paints have been developed which will deposit a film of metallic zinc having many properties in common with zinc coatings applied by hot-dip galvanizing, electroplating, metal spraying and sherardizing. Such paint films will protect the underlying steel sacrificially provided they contain 92 to 95 per cent of metallic zinc in the dry film and provided the

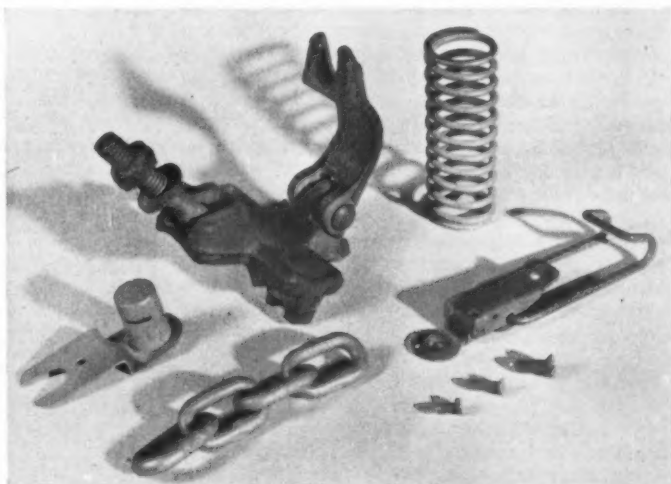
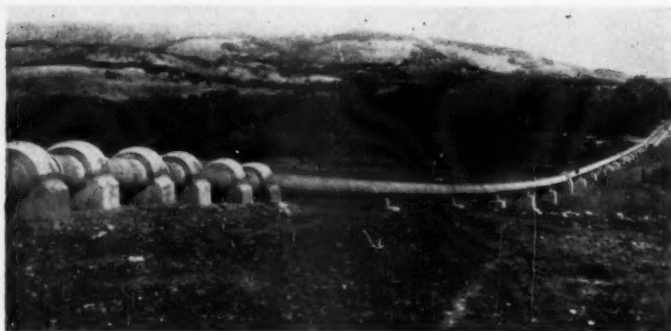


Fig. 14.—Some typical Sherardized parts.

Fig. 15.—Overland water pipe in South Australia protected by a zinc dust/sodium silicate type stoving paint.



film is in electrical contact with the steel surface at a sufficient number of points⁽¹⁸⁾.

Zinc dust has been used as a pigment in protective paints for more than 100 years⁽¹⁹⁾ but it is only in the last two decades that vehicles have been developed which make it possible to apply a paint film meeting the conditions set out above; paints based on plasticized polystyrene and chlorinated or isomerized rubber are most favoured in Great Britain. In the same period cementiferous zinc paints based on alkali silicates have proved extremely successful in protecting oil-storage tanks etc. in Australia against atmospheric corrosion, but they are not truly metallic. Other types of paints based on oxychloride and phosphate cements have recently been tested by Mayne and his co-workers at Cambridge⁽²⁰⁾.

The type of zinc dust used in protective coatings is a heavy powder, light blue-grey in colour with spherically-shaped particles having an average diameter of about 4 microns. Such powder normally contains 95 to 97 per cent of free metallic zinc with a total zinc content in excess of 99 per cent.

Most zinc-rich paints are of the air-drying type though stoving primers containing a high content of zinc dust are also available. Both types of paint are completely non-toxic and can be applied by either brush or spray gun or by dipping if adequate mechanical stirring is ensured.

It should be emphasized that only those paints which give dry films containing about 95 per cent or more of metallic zinc are considered in this section. The widely used zinc-dust/zinc-oxide primers based on ordinary drying oil media do not give general electrolytic protection against corrosion and so do not fall in the category of zinc-rich paints, or zinc metal-pigmented paints as they are sometimes known.

Advantages and Limitations of Zinc-rich Paints

An immediate advantage of the use of zinc-rich paints is the simplicity of their application as no special equipment is required. They can be used

indoors or out with equal facility and to large and small structures.

A further practical advantage lies in the amount of surface preparation required. This need only be sufficient to establish adequate electrical contact with the basis metal and recent work by Mayne⁽²¹⁾ has shown that zinc-rich paints will, under certain conditions, function on top of a thin film of hard and adherent rust or scale, though not, of course, on a loose or heavily rusted foundation.

Zinc-rich paints have comparatively poor abrasion resistance compared with that of other types of zinc coating, though it compares well with that of other types of paint. The paint film is fairly porous and relies on electrolytic action to protect the underlying iron or steel surface. They are thus particularly effective when immersed in sea water and one of their most important fields of application is the protection of the underwater surfaces of ships.

In applying zinc-rich paints, some difficulty may be caused by the tendency of the pigment to settle. This is often overcome by providing thinners to be mixed in just before the paint is used⁽²²⁾.

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DETROIT, 1959

Some Impressions of the Fifth International Conference on Metal Finishing

by J. G. LEMON and T. E. SUCH*

THE International Conferences on Metal Finishing are momentous occasions for the Institute of Metal Finishing, and the American Electroplaters Society. Organized jointly by these Societies, these functions are held at approximately five year intervals and rank as the most important organized by them. The 5th International Conference held in Detroit from June 15th to June 19th was no exception to this. Combined with the celebrations of the Golden Jubilee of the founding of the A.E.S., this Conference was of particular significance to that Society. Our American hosts made a wise choice of both city and headquarters for this Conference—or as they say—Convention.

Detroit—the centre of the motor car industry—has long been famed for the large amount of hardware that has to be electroplated to keep pace with the huge output of their automobile plants. Due to this, much research work has been done at various companies there on many aspects of metal finishing and is leading to many improvements in finishing technique. The Hotel Statler-Hilton provided many of the delegates with an excellent base and all the members—over 1800 of them altogether—with a venue, including ample accommodation for the main technical sessions. These were often attended by over 500 platers. However room was found for all and with the good loud speaker system the back-room boys fared as well as those in the front seats.

As the delegates assembled on the Sunday, it was a great pleasure to renew old friendships and make new ones as people arrived to register. Later there was a "Get-together Party" in the evening, but on this occasion conversation was necessarily more strident than intimate for the background music was anything but soft. Nevertheless the atmosphere of bonhomie provided a good occasion to get acquainted.

At the opening session on Monday morning, June 15th, the Officers and Guests of the A.E.S. were introduced with due ceremony. Dr. T. P. Hoar and Dr. S. Wernick were on the platform to represent the I.M.F. After the invocation had been given and the general Chairman, Mr. Wright Wilson, had formally declared the convention open, the delegates were welcomed by the Mayor of

Detroit on behalf of the Motor City, also by Mr. Herberth Head, president of the A.E.S., and the Lt. Governor of the State of Michigan. Then Dr. A. Brenner was next on the rostrum to announce the second winner of the A.E.S. Scientific Award, that Society's highest honour. Dr. A. K. Graham was the chosen recipient, and he was warmly applauded by the assembly.

The principal address at the opening Ceremony was given by Mr. Irving Duffy, Vice-President of the Body Group of the Ford Motor Company. In his talk, Mr. Duffy reviewed the recovery of the U.S. economy and outlined the severe challenges that lie ahead for the plating industry, particularly in improving the corrosion resistance of plated articles, the styling of which is likely to become even more intricate.

The Grand Old Man of plating Dr. William Blum—still in great heart—opened the afternoon session giving the first of the lectures to be named after him, as the first recipient of the A.E.S. Scientific Award. He chose for his subject "Education and the Electroplating Industry." Dr. Blum recommended various means of educating people in the plating industry from those on the shop floor to management and also suggested ways of telling the general public more about plating and what it can do. While Dr. Blum was able to expand a little on this subject, the rest of the afternoon gave us a foretaste of what was to come in the way of hustle in presenting the technical papers, a total of 44 of which were presented.

Those who attended the 4th International Conference in London in 1954 will remember that 32 papers were then presented and that the 7 technical sessions were very rushed, and will therefore appreciate the difficulties of cramming 44 papers into 8 half days and 11 sessions. No preprints were available, so delegates had to be present at any paper which appeared interesting to them from a brief synopsis. Unfortunately with the authors limited to 20 mins. each they had to leave out a large majority of their work and with nothing printed being available, one had to rely on one's own scribbled notes as an immediate record of their resumes. The ten minutes usually allowed for discussions was not sufficient to allow for more than snap questions and answers. It was difficult to make constructive criticisms of the statements

*Both of W. Canning and Co. Ltd.,
Gt. Hampton Street, Birmingham, 18.

given as facts, when the authors often had no time to present the evidence behind them.

Sometimes two technical sessions were on at the same time as a Work's Visit, which was unfortunate when all three appeared to be of interest. When two simultaneous sessions are held in rooms close together it is possible to move from one to another and hear the papers in which one is most interested—but when these rooms are separated by miles as was sometimes the case then this is obviously impossible, in spite of the excellent coach system laid on between the Statler-Hilton and the Detroit Armory. It does seem that a little more selectivity in choosing the papers would have cut down the number to a reasonable extent.

Nevertheless some most interesting papers were presented. A perusal of a list of them shows that the whole range of Metal Finishing was covered. It was notable that of the 24 papers connected only with electroplating, as distinct from other branches of metal finishing, one third was on the subject of the corrosion resistance of decorative nickel and chromium deposits—a subject which is uppermost in the minds of platers in the U.S.A.

It was interesting to note that very many cars of all types and makes seen around Detroit showed considerable areas of corrosion after what must have been a relatively short service life. This corrosion, which was to be seen both on the painted body and plated parts was, we think, rather more than would be found on cars of the same age in Britain.

The Finishing Exhibition was opened on Tuesday in the Detroit Artillery Armory, the headquarters of the National Guard unit—about 8 miles from the Statler-Hilton Hotel. Some of the technical sessions were also held there. A total of about 150 companies exhibited their products in the hall covering the whole range of materials and processes needed by the finishing trade. The products on view were mainly conventional—most of the items being similar to those on view in England. However it was a most useful opportunity to see competing products under one roof almost side by side and compare their various features without being bothered too much, for the temperature was so high that even American salesmen were flagging by the end of the day. In fact the heat and humidity were so bad that one wondered if corrosion test cabinets were really necessary to stimulate tropical conditions—although we could never get an American to admit that it was really hot! As well as the new developments obviously rushed through to be in time for featuring at the show, other stands exhibited the plating methods of the past, making an interesting contrast.

Included in the 1800 or more people either slaking their thirst for knowledge at the technical sessions or exhibition, or just slaking their thirst,

was a large overseas contingent of about 50. It was pleasing to note that 30 of these came from Great Britain. The European continent was also represented; in particular Germany and France each sent several visitors. Other delegates were present from all over the world, some from as far away as Australia and Japan. Canada—being just over the river—was well represented by native Canadians and ex-patriate Britons, who were eager for the latest news from home.

The social functions were well attended and gave an opportunity for conversations which were not wholly connected with plating, although platers being what they are, shop was inevitable. The ladies appeared to have an even more strenuous programme than the men and were able to participate in visits to various places of interest every day of the Convention; even the children had their own trips to the Zoo and so on. The social activities culminated in the Golden Jubilee Banquet and Ball on Thursday evening, when so many attended that four other rooms had to be used in addition to the main ballroom.

We did not ourselves go on these organized plant visits which were made to the Ford plant at Dearborn, the Chrysler Engineering Laboratories, and the General Motors Technical Centre. However we visited several others during the next two weeks. It was most interesting to see the large plating plants in operation and to note that, although their size was greater and more automation was used, their problems and techniques were very much the same as ours. The smaller general shops also compared closely with ours.

There is no doubt that the plating industry in the U.S.A. is concerned about the competition being experienced from stainless iron and anodized aluminium and has taken active steps to combat this by using thicker coats of nickel (possibly as a dual-coat) and or thicker chromium to improve the corrosion resistance of the plated articles.

In spite of the deal of talk about high-speed bright nickel plating, the range of current densities commonly encountered is 35 to 45 amp. per sq. ft. Raising the current density would certainly present problems in plate distribution on the intricate shapes that now have to be plated.

Use is made of robbers and plastic shields as in the U.K., in spite of the greater anode/cathode distance normally employed in the U.S.A.

The d.c. current is often supplied by generators but germanium and silicon rectifiers are becoming more popular.

Automatic polishing is of course a necessity in car factories, but always standing at the end of the polishing machine are men with polishing wheels on flexible drives for "touching up." Liquid spray polishing composition is largely used for these

(Continued in page 325)

FINISHING POST

A SELECTION OF
READERS' VIEWS COM-
MENTS AND QUERIES
ON METAL FINISHING
SUBJECTS

The Delhi Pillar

Dear Sir,

I notice that in page 209 of your May issue reference is made to the longevity of the famous iron pillar at Delhi, which has suffered very little corrosion in the course of centuries.

It is not generally known that, in addition to the investigation by the late Sir Robert Hadfield, F.R.S., to which you refer, the British Iron and Steel Research Association has undertaken corrosion tests on a British steel exposed near the pillar. This was done with the collaboration of an Indian metallurgist. The results showed that the rate of corrosion of a British steel at Delhi was only 0.0002 in. per year. This is about one-tenth of the rate observed in rural atmospheres in Great Britain. This difference is accounted for by the dryness of the climate at Delhi. Meteorological records show that the average annual relative humidity there is about 46 per cent, which is well

below the critical value of 70 per cent that Dr. W. H. J. Vernon showed to be necessary for serious corrosion of iron. Presumably too, the atmospheric pollution at Delhi is very low.

Consequently, in my view, the freedom from corrosion of the Delhi pillar is to be attributed primarily to the mildness of the local corrosive conditions. I doubt whether the intrinsic corrosion resistance of the iron from which it is made will differ materially from that of comparable irons and steels manufactured elsewhere.

A detailed account of the experiments mentioned above will be found in "Nature," 1953, September 12, 499-500.

Yours faithfully,

J. C. Hudson.

British Iron and Steel Research Association,
140 Battersea Park Road,
London, S.W.1.
June 16th, 1959.

DETROIT, 1959

(Continued from page 324)

large polishing autos., but bar compo. is still holding its own in many plants for hand and even automatic polishing.

This week of lectures, excursions and entertainment went by very quickly; until Friday still saw the chairmen of the technical sessions maintaining just as good discipline over time allotted to authors as throughout the week and the audiences still bravely coming up for more. However came the evening and with the ending of the Convention, the delegates immediately started to disperse. This rapid exodus was due to the great distances they had to cover. When the rest of the visitors had gone on Saturday morning only a few of us foreigners were left. Soon the only physical reminders remaining of the Golden Jubilee Convention, were hasty notes—now, alas, realized to be far too scanty. However the memories of the kindness and hospitality of our American hosts will be recollected with pleasure over the years to come. It is on this note of thanks to the platers in the U.S.A. that we conclude.

(Note for those seeking more detailed information: A half day session on the 5th International Conference is to be held by the Midland Branch of the I.M.F. on October 6th at the Imperial Hotel, Birmingham, when members who were present, will summarize the papers presented).

FINISHING LUNCHEON CLUB

Start of 1959/1960 Session

The first meeting of the Finishing Luncheon Club for the 1959/1960 session will be held at the customary venue, the Rembrandt Hotel, on October 15 at 12.15 for 1.00 p.m. The speaker on this occasion will be Mr. H. A. Holden who will retail some of his impressions and experiences following his visit to the 5th International Metal Finishing Conference in Detroit last June.

Anyone interested in attending this or future luncheon meetings of the Club is invited to communicate with the Hon. Secretary at John Adam House, John Adam Street, London, W.C.2.

Zinc Coatings on Iron and Steel—2.

(References continued from page 322)

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Advantages of **POTASSIUM STANNATE**

in electro plating and immersion plating

The economic advantages of using potassium stannate are very considerable.

Probably the best known application in immersion plating is the tinning of aluminium pistons. By using potassium stannate instead of sodium stannate it is possible to achieve substantial reduction of sludge formation.

Solutions containing potassium stannate have a far greater electrical conductivity than similar solutions containing the same concentration of sodium stannate. This fact, and the greater solubility of potassium stannate, mean that higher current densities are obtained for a given voltage. Conditions are ideal for barrel plating. Alternatively a dilute potassium stannate solution can give the same plating rate as a more concentrated one containing sodium stannate, so that wastage by drag-out, and initial costs, are reduced considerably.

With High-Speed tin anodes faster plating rates can be obtained. Fewer anodes are required and 'filming' is much easier.

Albright & Wilson (Mfg) Ltd. also supply Phosbrite chemical polishing solutions for copper and aluminium and their alloys, Plusbrite addition agents for bright nickel plating, together with chemicals for special processes in copper and nickel plating and electrolytic polishing of ferrous metals.

For full information write to:

Metal Finishing Department
ALBRIGHT & WILSON (MFG) LTD
1 Knightsbridge Green, London SW1
Telephone: KENSington 3422

FINISHING

NEWS REVIEW

Congress on Metallic Corrosion

THE first international congress on metallic corrosion will be held in South Kensington, London during the week April 10-15, 1961, under the presidency of Sir Harry Melville, K.C.B., D.Sc., F.R.I.C., F.R.S.

Mr. E. Leslie Streatfield has been appointed chairman of the executive committee and Dr. J. Ferguson chairman of the finance committee. The honorary secretary is Lt.-Col. Francis J. Griffin from whom further information can be obtained at 14, Belgrave Square, London, S.W.1.

Plating Shop Lectures

Borough Poly puts on management and control series

A course of six lectures on plating shop management and control has been arranged by the Borough Polytechnic, London S.E.1, in collaboration with the education committee of the Institute of Metal Finishing.

The lectures will be given at 7 p.m. on each consecutive Tuesday from October 6 to November 10. Mr. E. A. Ollard, A.R.C.S., F.R.I.C., F.I.M., will give five of the lectures and Mr. A. R. King, the manager of the plating and radiator division at Vauxhall Motors Ltd., Luton, will give the other. The full programme is as follows:—

Lecture No. 1

Choice and layout of plant, with special reference to economic factors. Tax allowances and depreciation. Factory regulations and Local Authority regulations. Drainage problems. Estimation of installation and working costs.

Lecture No. 2

Detailed organisation of the plating shop. Welfare schemes. Pension schemes. Human relations and the work of industrial psychologists.

Lecture No. 3

Work study, method study and work measurement and their application to plating shops. Determination of the optimum size of vats and jigs. Movement of materials, conveyors, trucks, etc.

Lecture No. 4

Costing methods suitable for plating shops. Budgetary control. Special problems encountered in the out-plating trade.

Lecture No. 5

The manufacturing shop and its place in a large organisation. Shop and factory overheads. Internal costing schemes. The position of the foreman in a large organisation.

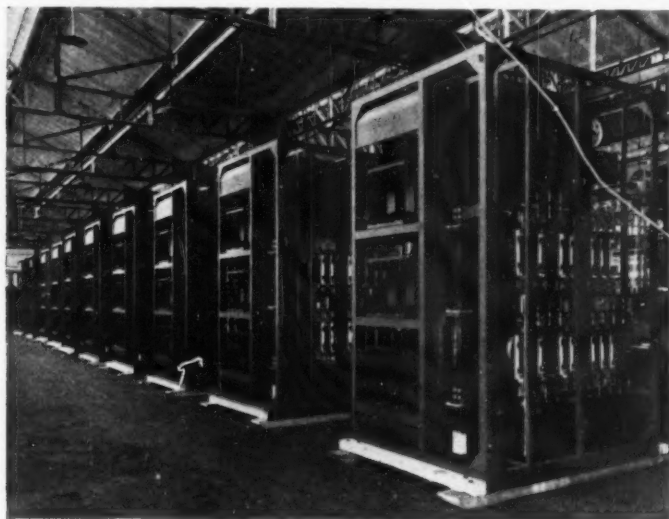
Lecture No. 6

Accounting methods for use in plating shops.

Corrosion problems joint symposium

A JOINT symposium on corrosion problems of the petroleum industry organized by The Institute of Petroleum and the Society of Chemical Industry is being held on November 26 and 27 in the Grand Council Chamber of the Federation of British Industries.

A reception will be held at 6 p.m. on the evening preceding the conference at the Washington Hotel, Curzon Street, for participants and their friends. Preprints of papers will be obtainable in advance.



SELENIUM RECTIFIERS FOR GALVANIZING

SEEN in the photograph above is part of a 60,000 amp. rectifier made by the Westinghouse Brake and Signal Co. Ltd., in the company's Paris factory. The equipment is destined for a French steelworks.

An order for a similar Westinghouse water-cooled selenium rectifier has been received from Japan, through the Electro-Chemical Engineering Co. Ltd. The equipment will be used to apply a zinc coating to steel sheet by the electro deposition process.

CHANGES were announced recently in the leadership of one of Britain's industrial giants, Imperial Chemical Industries Ltd., due to take effect in February of next year.

Sir Alexander Fleck, K.B.E., D.Sc., LL.D., F.R.S., is to retire from the chairman's post and will be succeeded by Mr. S. P. Chambers.

Perhaps the change is significant. For Sir Alexander was an expert in the practical side of the company's work, whereas Mr. Chambers is a leading figure in the world of economics. Following are brief details of the careers of the two men.

Sir Alexander Fleck, K.B.E., D.Sc., LL.D., F.R.S.

Sir Alexander Fleck became chairman of Imperial Chemical Industries Ltd. in June, 1953. Like Lord McGowan and Mr. John Rogers, his two immediate predecessors as I.C.I.'s chairman, who are also Glasgow men, Sir Alexander Fleck climbed the ladder from the bottom.

Born in Glasgow in 1889, he started his working life as a "lab" boy at Glasgow University, where, after three years, his keenness for continuing education enabled him to become a full-time student. By very great determination he gained a chemistry degree at the age of 22 and an appointment on the University's teaching staff as an assistant in the physical chemistry department.

Early radiological research

By 1913 he had his own research laboratory as physical chemist to the Glasgow and west of Scotland radium committee. His work there was concerned with radiological research on cancer. He gained his doctorate for a thesis based on work done in the University chemical laboratory entitled "Some chapters on the chemistry of the radio elements."

The vast and high-speed expansion of the British chemical industry during the first world war drew Sir Alexander into the Castner-Kellner Alkali Co. Ltd., which became in 1920 a subsidiary company of Brunner Mond & Co. Ltd. The I.C.I. merger in 1926 gave his talents wider scope, and by 1931 he had risen to be managing director of I.C.I.'s general chemicals division. Six years later he was appointed chairman of I.C.I. (fertiliser and synthetic products) Ltd., the predecessor of the Billingham division of I.C.I.

Sir Alexander joined I.C.I.'s main board in 1944 as director responsible for the Billingham division and also for central agricultural control (I.C.I.'s organisation responsible for agri-

cultural policy). Wilton — I.C.I.'s newest development — was added to his responsibilities in 1946. From 1951 until his appointment as chairman he was one of the company's deputy chairmen.

Honoured by science and industry

Sir Alexander's contributions to science as well as industry have been widely recognised. In 1953 he received an honorary LL.D. from his alma mater, Glasgow University. In the same year the University of Durham, with which he has close connections, made him an honorary D.Sc., to be followed in 1956 by Oxford University, and, in November 1957, by London University. In the same month he was made an honorary fellow of the Manchester College of Science and Technology. In 1958, he received two more honorary degrees: in May, a D.Sc. from Nottingham University and, in October, an Sc.D. at Dublin.

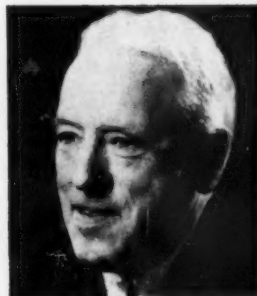
Messel Medal award

Sir Alexander's scientific work received further recognition when, in 1955, he was elected a Fellow of the Royal Society. A year later he was presented with the Messel Medal, the highest award to be conferred by the Society of Chemical Industry. In 1957 the Royal Society of Edinburgh elected him to an honorary fellowship, a distinction limited by statute to twenty-two members of the British Commonwealth who have made notable contributions to science or literature.

In 1958, Sir Alexander was presi-

Changes at the top in I.C.I. boardroom

Sir Alexander Fleck retires: his place will be taken by Mr. S. P. Chambers



Right:
Stanley Paul Chambers



dent of the British Association for the Advancement of Science and, in the course of the Association's annual meeting in Glasgow he was elected an honorary fellow of the Royal Faculty of Physicians and Surgeons of Glasgow. He is also a trustee of the new Churchill College at Cambridge.

N.C.B. report

It will be recalled that Sir Alexander was chairman of the advisory committee invited in 1953 by the National Coal Board to review the organisation of the coal industry. The Fleck report on that industry aroused great interest when it was published in February, 1955, and many of its recommendations have since been implemented.

Sir Alexander received the K.B.E. in the Birthday Honours list in June of that year "for services to the Ministry of Fuel and Power."

In November, 1957, he was made chairman of the three committees charged with the investigation of matters arising from the accident at the Windscale establishment of the U.K.A.E.A., where overheating took place in one of the graphite piles.

Shortly afterwards he was appointed to the chairmanship of a committee nominated by the Government to enquire into the British fishing industry. In September, 1958, the Minister of Power appointed Sir Alexander as chairman of his scientific advisory council, which was set up in 1948 to advise the Minister on the scientific aspects of his statutory duties.

(Continued on page 332)

I.M.F. October Symposium

THE Midland branch of the Institute of Metal Finishers are to hold a symposium on October 6 at the Imperial Hotel, Temple Street, Birmingham, to report on the proceedings of the Detroit metal finishing conference that took place last June.

Commencing at 2 p.m., the meeting will be divided into three sessions. Each session will deal with a series of papers presented at the Detroit conference, reported on by people who attended. After each report, a discussion will take place.

The reporters will include Dr. S. Wernick, Mr. U. F. Marx, Dr. W. Stein, Dr. T. P. Hoar, Mr. T. Such, Mr. A. W. Brace, Mr. R. A. F. Hammond, Mr. D. H. Lloyd, and Mr. A. W. Wallbank. The Institute extends a cordial invitation to all members and friends. Tea and a buffet supper are to be provided without charge by Henry Wiggin and Co. Ltd.

REDUCTIONS IN TITANIUM PRICES ANNOUNCED BY I.C.I.

THE largest reductions so far made in the price of British wrought titanium have been announced by the Metals Division of Imperial Chemical Industries Ltd.

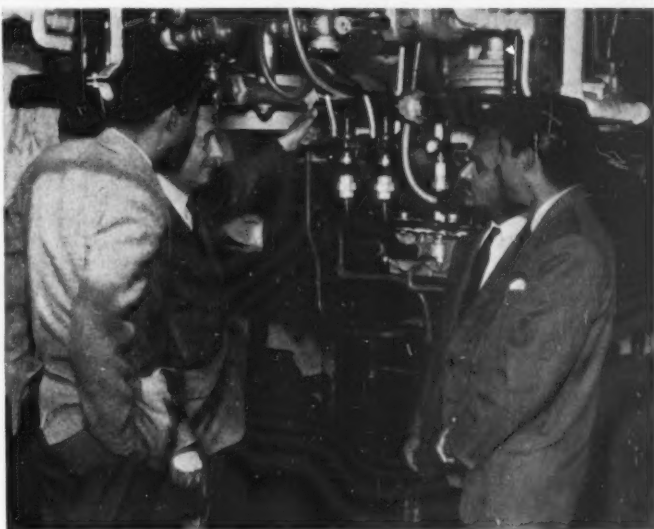
The heaviest cuts are in prices for sheet, strip, plate and wire, which are reduced by 25 per cent. Rod and billet prices are cut by 15 per cent, and extrusions (latest addition to the range of I.C.I. wrought titanium products) by 12½ per cent.

These reductions—the second in twelve months—bring the price of I.C.I. wrought titanium to less than half the level operating in 1955, when the company started commercial production.

In four years, British titanium has made remarkable progress. It is already firmly established as a structural metal for aircraft and chemical engineering in applications where its unique properties justify the initial cost. Clearly, however, it will only achieve its full commercial potential when its price becomes more directly competitive with that of conventional materials.

To this end, I.C.I. has followed a declared policy of reducing prices as rapidly as can be justified by increasing demand and higher plant efficiency.

Overseas Users Visit Vulcans



Chief engineer Mr. Brant explains the workings of a modern varnish kettle

OVERSEAS visitors to the industrial paints factory of Vulcan Products Ltd., Slough, part of the industrial division of Blundell, Spence and Co. Ltd., were ten senior Bahraini members of Caltex's Bahrain Petroleum Co. Ltd., (Bapco).

They are on a nine-weeks study tour of Britain, as part of their company's plan to train Bahrainis to take an increasing part in its operations at supervisory and administrative levels. Accompanied by Mr. E. A. Allen, an instructor at Bapco's training centre, the ten men are seeing at first hand all the major aspects of British life; its history, culture, sport, the arts and sciences, central and local government, industry and finance.

Their visit to Vulcan Products, where vehicle finishes and a wide range of other industrial finishes are made, was the first of their industrial tour. In small groups they were shown round the factory by Mr. F. R. Eden (works director), Mr. W. Gage (assistant works manager), Mr. E. H. Brant (chief engineer), Mr. J. Cresswell and Mr. R. L. Tully (technical advisers) and Mr. S. R. Finn (chief chemist).

The Bahrainis had a special interest in this factory, for Bapco use a large quantity of Vulcan finishes every year on vehicles, derricks, machinery and oil pipes.

While at the factory the Bahrainis also learned something about Pam-

mastic plastic emulsion paint, manufactured by the decorative division of Blundell, Spence and Co. Ltd. The basis of this paint is manufactured by the Dunlop Rubber Co. Ltd., one of whose factories they visited later in the tour.

Vacuum metallising in Cambridge plant

WITH premises in the centre of Cambridge, a new company has been formed to advise on the design and manufacture of all types of special vacuum equipment for use in the high, medium or rough ranges, with special emphasis on metallurgical equipment and batch and continuous metallising.

The company, Torvac Ltd., with a development works at Histon, on the outskirts of the town, has access to experience accumulated over many years in the design, construction, testing and operation of vacuum metallising, and other vacuum processes.

Associated with the new concern is Mr. M. E. Boston as vacuum engineering consultant.

A major user of finishing products, the London Transport Executive has started work on a new research block to rehouse sections previously dispersed.

L.T.E. goes ahead with new research block

WORK has begun at Chiswick on a new two-storey building to house the central laboratory of London Transport's research department. It will enable the scientific staff for the first time to be under one roof instead of in scattered, cramped accommodation in various parts of the Chiswick works estate. The new premises will have a floor area of 26,000 sq. ft. and will give space for additional staff and for important new apparatus.

Among the facilities to be provided are a cold chamber for low-temperature testing, a specially-designed, screened room for work with a 200-kV. industrial X-ray apparatus and for gamma-radiography using a cobalt 60 source, heat-treatment furnaces and welding equipment, a pilot plant laboratory, special recording equipment for strain gauge tests, and a fatigue testing machine for railway car axles—the only one of its kind in Great Britain.

Not only does the research department undertake specialised work, but it carries out regular routine investigations of stores and materials purchased by London Transport, and is responsible for the technical control of certain works processes. It is equipped with a wide variety of testing apparatus for these purposes.

International standing

The work of the department enjoys an international reputation, and papers by Mr. A. T. Wilford, director of research, and members of his staff are regularly and widely reported in the technical press at home and abroad.

There has been a chemical laboratory at Chiswick works since 1921, first opened by the London General Omnibus Co., and the first stage of the new laboratory project was completed in 1957, when a small single-storey building was erected to provide accommodation for certain specialised manufacturing activities which up till then had been carried out in a temporary hut; this building also includes an inflammable liquid store and space for what will eventually become a pilot plant laboratory, though it is at present being used as a paint application laboratory pending completion of the main building.

In planning the layout of the new central laboratory, the principal aims have been to keep related functions together and to accommodate heavy machines and equipment on the ground floor. With this in view, the laboratory for the mechanical testing of lubricants, the machine shop, engineering laboratory, cold

chamber, radiography room, battery-testing laboratories and laboratory for mechanical testing of metals are situated on the ground floor. On this floor, also, are the metal-chemistry laboratory and rooms for microscopy, non-destructive testing, and technical photography, the last-named being conveniently linked with radiography and metallography, though much photographic work of a more general character is also carried out. The physics laboratories and photometry room, main stores, and rooms for the preparation of reagents and for the cleaning of sample bottles and glassware are also on the ground floor.

Chemical laboratories

The upper floor has groups of laboratories devoted to testing of fuels and lubricants, paints and allied materials, and textiles, and for general chemical work of an exceptionally wide range. In each group, one or more small laboratories are provided for investigational and research work and, in particular, one of the chemical laboratories has been designed to be suitable for work involving the use of radio-isotopes at a low level of activity.

Exposure testing

The paint application laboratory is connected with the Stage I building by a covered bridge, giving access to the roof of the smaller building, which will be used for weather-exposure testing of paints. It will replace the station at present on the roof of the Chiswick works canteen; a second test station on the roof of Upton Park garage will be retained so that tests can be made under atmospheric conditions in both east and west London. In addition to direct exposure to the weather, accelerated weathering tests on paints will be carried out, using an existing apparatus which will be rehoused in the new laboratory.

Services of gas, electricity, compressed air, and steam are provided on both floors, together with a pressurised water supply, since it is no longer permissible to connect

mains supply water direct to laboratory benches.

Surface treatment laboratory

As with the present laboratory, the new central laboratory will be concerned with regular testing of supplies, involving both chemical and physical tests and the use of mechanical testing equipment. Technical control of works processes such as cleaning and degreasing, metal protection, spray painting and stove enamelling, welding, heat-treatment, and heavy electro-deposition will also be continued; for these purposes the new building is conveniently sited in relation to both Acton works (railway) and Chiswick works (bus).

Longer-term investigations in the nature of technical research will also be undertaken, and much valuable work has been done in connection with metal protection, painting processes and the design of lead-acid accumulators. Other long-term activities include investigations with the object of prolonging the life of metal components in service (railway car axles for example) and to determine the stress loading of equipment under service conditions. The improved facilities to be provided in the new building will make possible more rapid progress in these important investigations and will widen the scope of such work. It will also be possible to undertake rig-testing and the testing of materials and components, both mechanical and electrical, under controlled conditions.

Paint testing facilities

Facilities for paint testing will be enhanced by the provision of a water-back paint spray booth. Many new items of equipment will also be provided for the chemical laboratories and will include visible and ultra-violet spectrophotometers, a flame photometer and an automatic titration apparatus. The large amount of apparatus and equipment, much of it up-to-date, at present in use in the various laboratories will, of course, be transferred to the new building.

The new central laboratory has been designed to the requirements of Mr. A. T. Wilford, A.R.C.S., B.Sc., F.R.I.C., F.S.S., C.I.Mech.E., F.Inst.Pet., director of research, London Transport Executive, by Messrs. Adie, Button and Partners, architects, under the general direction of Mr. T. R. Bilbow, F.R.I.B.A.

Nickel Shares Pay More

PAST THE RECESSION, INTERNATIONAL NICKEL EARNINGS REFLECT INCREASED USE OF METAL

THE interim report of The International Nickel Co. of Canada Ltd. records earnings equivalent to \$ (U.S.) 2.63 per common share for the first six months of this year compared to \$ (U.S.) 1.46 for the same period of 1958. This rosier picture for nickel investors shows a remarkable pickup in nickel earnings from the decline that set in after the first half of 1957 when earnings per share reached the figure of \$ (U.S.) 3.12.

Expressed in terms of U.S. dollars, earnings in the first six months of this year totalled \$38,391,000 net.

Nickel deliveries up

The increase in the earnings during the first six months over those of the comparable period last year resulted primarily from the revitalised demand for the company's products, chairman John F. Thompson and president Henry S. Wingate stated in their remarks to shareholders. The major contributing factors were an increase of over fifty per cent in the rate of nickel deliveries in all forms and the improvement in the market price for copper. The fears of a steel strike in the United States, now materialised, contributed to the heavy second quarter demand for nickel from that industry.

Plating industry major users

In a letter to shareholders accompanying the interim report, Dr. Thompson discussed nickel plating that accounts for about 15 per cent of the free world's nickel consumption. Dr. Thompson thinks that in the future, the plating industry will be a still greater consumer of nickel, "since it has tremendous market potentialities." At the moment, the automotive industry is the largest consumer of nickel for plating.

"A major advance in the electroplating industry has been the development of the so-called 'duplex' nickel plating systems in which two successive layers of nickel are deposited, imparting marked improvement in corrosion resistance and quality of finish," Dr. Thompson says. "Costly buffing and polishing operations are virtually eliminated and service life is extended."

"The plating field is an important market for nickel," he went on. "International Nickel's research and market development staffs are constantly conducting studies and disseminating information with the objective of improving the techniques of nickel plating, not only to retain the present market but to expand it by finding new uses and applications."

BRITISH MATCH CORPORATION INCREASES WIRE BRUSH INTERESTS

THE British Match Corporation has acquired the entire share capital of L. N. Mills and Co. Ltd. of New Malden and its three associated companies, the London Wire Co. Ltd. formed in 1935, Sunray Products (Rubber) Ltd., and Rotary Brush Wheels Ltd. formed in 1949.

British Match in 1948 gained ownership of three companies manufacturing steel wool, soap-filled scouring pads and scouring cloths.

In 1919, L. N. Mills and Co. Ltd.

AEROSTYLE JOINS MILES HIVOLT IN AIRLESS SPRAY PLANT

IN conjunction with Miles Hivolt Ltd., Aerostyle Ltd. of Acton announce that they are entering the field of high-voltage airless painting equipment—electrostatic painting.

Details of new equipment will shortly be available.

NEW COMPANIES

"Ltd" is understood also "Private Co." Figures—Capital, Names—Directors, all unless otherwise indicated.

Anodic Nameplate, 6, Ashton Street, Dunstable, Beds. July 13. £200. Harold Denby.

Emslie Fallows, July 14. £100. To carry on bus. of manufacturers of and dealers in compounds and materials for finishing and polishing plastics and metals, etc. Edward C. Emslie, Frederick J. Fallows.

Frank Gregory (Paints), 33, Jack Lane, Davenham, Northwich, Ches. July 15. £1,000. Frank Gregory and Ruth Gregory.

Calovent, July 15. £500. To carry on bus. of designers and manufacturers of and dealers in heating panels and heating equipment fittings, etc. Graham Bell and Clifford B. Peacock.

Industrial Spraying (Harlow), The Stud, Gilston Park, Nr. Harlow, Essex. July 17. £100. Josephine P. Plant, Clifford J. Saunders.

Paint Alliance (Bristol), Avon Street, St. Philips, Bristol. July 27. £100,000. To acquire the whole or parts of the undertaking and assets of Will's Paints, Ltd., John Hare and Co. (Colours) Ltd., and Taylor's Paints Ltd., etc. Arthur J. Bishop, Ian H. Phillips, Reginald H. Taylor,

Josephine J. G. Bromell and John Day.

Strong and Woodhatch, Market House, The High, Harlow, Essex. July 23. £5,000. To carry on bus. of gilders, electro, nickel and chromium platers, etc. Lawrence H. Woodhatch and Mrs. Elsie H. Woodhatch.

Redditch Industrial Finishing Developments, Beoley Mill, Beoley Road, Redditch, Worcs. July 24. £6,000. Richard Bennett, Albert G. Griffin.

Filtration Service Engineering, 15, Streetsbrook Road, Shirley, Solihull. July 28. £1,000. Henry J. Perry and Dora M. Perry.

H. Nicholls and Co. (Chemicals), 71, Barton Road, Worsley, Nr. Manchester. July 29. £2,000. Herbert Nicholls, Lily Nicholls, Shirley Nicholls and Barry Nicholls.

Jenton Products, 31, Range Road, Whalley Range, Manchester, 16. July 29. £1,000. To carry on bus. of manufacturers of and dealers in paints, varnishes and enamel, etc. Thos. F. Jennings, Chas. A. Etherington.

From the Register compiled by Jordgn & Sons Ltd. 16 Chancery Lane, London, W.C.2.

Technical & Industrial Appointments

National officers for the **American Society for Testing Materials** were elected at the society's annual general meeting held in Atlantic City, N.J., recently.

F. L. LaQue, vice-president and manager, development and research division, The International Nickel Co. has been elected president. Miles N. Clair, president, The Thomson and Lichtner Co., has been elected vice-president. A. Allan Bates, vice-president of research and development, Portland Cement Association, will continue as senior vice-president.

Elected for three-year terms on the board of directors were the following: A. B. Cornthwaite, engineer of materials and tests, Department of Highways, Commonwealth of Virginia; C. L. Kent, assistant director of technical services, The Jones and Laughlin Steel Corporation; H. C.

Miller, laboratory engineer in charge of the testing laboratory, Public Service Electric and Gas Co. (N.J.); C. E. Nixon, head, electrochemistry and polymers department, research laboratories, General Motors Corporation; H. D. Wilde, research co-ordinator, Humble Oil and Refining Co.; and I. V. Williams, materials engineer, Bell Telephone Laboratories.

Elected for a two-year term, in accordance with a change in the society's by-laws, is Robert D. Thompson, chief development engineer for Commercial and Glass Products, Taylor Instrument Co.

The sales department of **Nash and Thompson Ltd.**, Chessington, Surrey, England (Elmbridge 5252), has been re-organised. Mr. J. L. Foreman, who has been appointed

sales manager, was previously a commercial manager in the Elliott-Automation Group. Mr. Foreman is responsible for home and export sales policy, publicity and market research.

Mr. D. E. Morris, previously a sales engineer in the company, has been promoted to sales office manager with special responsibility for process control, oil, gas, mining, medical and survey equipment. Mr. R. C. Blezard is the sales engineer responsible for all metallurgical sales and Mr. T. N. Mordue covers the counties south of the Thames for the "Nash-ton" range of miniature electronic test equipment.

The sale of scintillators is now covered by Mr. D. A. Ginger, chief chemist, and environmental testing by Mr. G. F. Thompson, head of the component testing laboratory.

I.C.I. Changes

(Continued from page 328)

Mr. S. P. Chambers

Stanley Paul Chambers was born in London in 1904. He was made a deputy chairman of the company in 1952, having joined the board in July 1947, and been finance director since early in 1948.

He took a master's degree in economics at the London School of Economics, of which he is now a governor.

His career started in the Inland Revenue Department in 1927. In 1935 he was a member of the Indian income-tax inquiry committee and later acted as taxation adviser to the Government of India, during which time he became a member of the Indian Legislative Assembly and later of the Council of State; for his services in India he was created a Companion of the Indian Empire.

Taxation expert

Returning to this country in March 1940, Mr. Chambers was appointed director of statistics and intelligence and assistant secretary to the board of Inland Revenue. In 1942 he became secretary to, and a member of, the Board of Inland Revenue; for his inland revenue work he was created a Companion of the Bath in 1942.

He visited Washington in 1944 in connection with the negotiations for the comprehensive double taxation agreement which was subsequently entered into between the United States and Britain.

At the end of the war he was appointed chief of the finance division of the British element of the control commission for Germany, which post he held until he left the public service to join the Board of I.C.I. on July 10, 1947.

Service on official committees

He has been a member of several government committees, including one which investigated the higher organisation of the War Office, another which investigated the organisation of the Board of Customs and Excise, and a third which reported on the difficult problem of the disposal of government archives, in connection with which he visited Washington in 1953.

In 1953 he accepted an invitation by the Government to be the chairman of a committee of inquiry into London transport.

Mr. Chambers is also a director of the National Provincial Bank Ltd., the Royal Insurance Co. Ltd., the Liverpool, London and Globe Insurance Co. Ltd., African Explosives and Chemical Industries Ltd., and several other companies, and is a part-time member of the National Coal Board.

His non-business activities include being a member of the board of governors and chairman of the educational trust committee of the English-speaking Union of the Commonwealth. He is also president of the National Institute of Economic and Social Research, and is a member of several other organisations interested in social and economic questions.

A member of the Powell Duffryn Group, **Cory Brothers and Co. Ltd.**, has acquired the share capital of MacClester Chemical Co. Ltd.

The MacClester Company will continue to operate under its own name and the present directors, Mr. N. R. MacClester and Mr. R. A. L. Thornton, will remain on the board. Additional directors appointed are Brigadier S. J. L. Hill, D.S.O., M.C. (chairman), and Mr. John Wm. Davies, both also directors of Cory Brothers, and Mr. J. W. Franklin. The company's address is now 8, Great Tower Street, London, E.C.3. Telephone: Mansion House 4555.

MacClester Chemical Co. Ltd., a private company formed four years ago, manufactures a range of anti-corrosion compositions for the protection of metals which have wide applications in industry, shipping etc.

Mr. C. A. McNeill, C.G.I.A., M.A.I.E.E., has joined the technical sales staff of the **Electric Resistance Furnace Co. Ltd.** at their midlands area office in Birmingham. Mr. McNeill is an experienced electrical engineer who has specialized in electric furnaces for many years. He was formerly technical sales manager of another furnace manufacturing company.

Mr. M. J. Parsons who has worked for many years with Edwards High Vacuum Ltd. has joined the sales organization of the Electric Resistance Furnace Co. Ltd. at their head office in Weybridge, Surrey. He will specialize in vacuum heat treatment processes and equipment.

Sel-Rex establish European Division**Rochat Heads New Factory**

THE establishment of a European division in Geneva, Switzerland, with complete facilities for manufacturing and marketing their precious metals plating processes and equipment, has been announced by the Sel-Rex Corp., Nutley, New Jersey, U.S.A. Managed by newly-named vice president Rene J. Rochat, Sel-Rex's European division has the responsibility of coordinating the activities of an extensive distributor's network covering major industrial centres in Asia, as well as Europe.



Rene J. Rochat

Swiss-born Rene Rochat goes to Sel-Rex with nearly 15 years' uninterrupted experience in the precious metals electroplating field. A graduate chemical engineer of the University of Geneva, he was formerly manager of one of the largest gold refining and precious metal plating operations in Europe.

Bill Zwerner, also an alumnus of the University of Geneva, in electrical engineering, has been named manager of manufacturing for the European operations. Mr. Zwerner has had extensive experience in the design and installation of electroplating facilities. He is reported to have engineered the installation of some of the largest precious metals electroplating operations in Europe.

Laboratory facilities to be provided

The establishment of the new division is said to have been necessitated by the rapidly growing demand for Sel-Rex products throughout Europe and Asia. In addition to supplying a focal point for marketing activities, Sel-Rex says their new division is equipped to perform analysis of solutions and electro-deposits, and to do sample plating with the various Sel-Rex precious metals processes.

It is reported that Sel-Rex's European division plans to investigate products of other American manufacturers for possible production and/or marketing through their Geneva headquarters and network of distributors.

In anticipation of the official opening of the new division, patents have already been secured on the company's various precious metals plating processes in countries where they will be distributed.

According to Morris M. Messing, Sel-Rex president, a large number of "Jet" platers have already been sold in Europe and Asia through the Geneva division, as well as substantial quantities of their precious metals plating processes. U.K. agents for Sel-Rex are M.L. Alkan Ltd., Stonefield Way, Ruislip, Mdx.

BELLE VUE FACTORY EXHIBITION

AN event in the London show calendar for the past few years, the factory equipment exhibition will be held in Manchester next year from September 21, at Belle Vue. Thereafter, it will be held in London (Earls Court) and Manchester in alternate years.

New arrangements include the grouping of the several hundred different types of exhibits into their various categories.

Of interest to readers of this journal, equipment and services for which there will be special sections include: cleaning and maintenance, product finishing, machines and tools, heating and ventilation, dust and fume extraction, construction and partitioning, packaging and packing.

Space well booked

Already 80 per cent of the space for the exhibition has been applied for, and some of the sections have already been fully booked, the organisers say.

Covering everything for the factory, from the building itself down to the smallest item of equipment, the exhibition has developed into an important event and is supported by over 150 associations, institutions and societies embracing every aspect of factory activity and management.

Eighth in a successful series, the 1960 exhibition will be organised by Industrial and Trade Fairs Ltd., the company jointly owned by "The Financial Times" and the George Newnes groups of companies.

MEETINGS OF THE MONTH

September 25

Institute of Metal Finishing (Sheffield and North East Branch). "The Trisec metal drying process," by G. Yeats, at the Department of Applied Science, Sheffield University, Mappin Street, Sheffield 1. 7 p.m.

October 14

Institute of Metal Finishing (Organic Finishing Group). Opening meeting, at 80 Fetter Lane, London, E.C.4. 6.30 p.m.

October 15

Institution of Plant Engineers (Glasgow Branch). "The engineer's approach to non-destructive testing of metals," by H. Potter, at the Scottish Building Centre, 425/7 Sauchiehall Street, Glasgow. 7.15 p.m.

October 15

Institute of Vitreous Enamellers (Midland Section). "Chemical resistance of enamels on domestic equipment," by N. S. C. Millar, at the Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. 7.30 p.m.

October 15

Institute of Vitreous Enamellers (Northern Section). "Spray Painting Methods" by a member of the Aerograph-Devilbiss Co. Ltd. (paper and film show).

October 19

Institute of Metal Finishing (London Branch). "High temperature anodizing," by A. W. Brace and R. E. M. Polfreman, at the Northampton Polytechnic, St. John Street, London, E.C.1. 6.15 p.m.

October 21

Institution of Plant Engineers (Kent Branch). "Metal spraying and ceramic coatings," by J. A. Sheppard, Metallizing Equipment Co. Ltd., at the Kings Head Hotel, High Street, Rochester. 7 p.m.

October 23

Institution of Plant Engineers (Birmingham Branch). "Industrial floorings," by W. J. Warlow, Building Research Station (D.S.I.R.), at the Imperial Hotel, Temple Street, Birmingham. 7.30 p.m.

Issue No. 19 of I.C.I.'s "Pretreatment News" describes pretreatment work on (1) Caterpillar tractors manufactured in the U.S.A., and (2) "Granodine" applied by the spray gun method to Isotta bubble cars made in this country.

The scale of production of the latter did not permit the installation of an elaborate plant, and "Granodine" was chosen because it can be applied by normal paint spraying apparatus.

Degreasing of the body prior to treatment is made by wiping with solvent-soaked rags. Treated in pairs the Granodine is allowed to remain on the work for the time it takes to spray each, about four to five minutes. Hosing down, first with cold and later hot water, is then carried out. An air blast is used to clear crevices, and the bodies are then forced dried for 8-10 minutes at 300°F. Red oxide stopping is subsequently applied to weld holes prior to finishing with I.C.I. stoving materials.

A leaflet recently issued by Albright and Wilson (Mfg.) Ltd., Metal Finishing Department, 1 Knightsbridge Green, London, S.W.1, describes some features of the Levelume bright nickel plating process. Set out as a table, the information covers applications, suggested composition of the plating bath, and operating details.

The process is applicable to the plating of steel pressings, forgings and zinc-based die castings, as well as brass and copper parts. The deposit obtained is fully bright with a white colour, ductile and receptive to chromium plating.

Leaflet No. 582 published by The Visco Engineering Co. Ltd., Stafford Road, Croydon, Surrey, describes the "Bermax" automatic dust collector made by the company, and intended to be complementary to their already established "Visco-Beth" collector.

The latter is a fully-automatic dry dust collector for the recovery of powders, such as chemicals, pharmaceuticals, etc., which have a saleable value. The Bermax has been introduced to provide a less costly but equally efficient collector for high temperature conditions, particularly suitable for the recovery of dusts of no commercial value.

Data Folder FD-18 published by Merit Products Inc., 3691 Lenawee Avenue, Los Angeles 16, Ca., U.S.A., and available in this country from the Sand-O-Flex Co. (Great Britain), Devonshire House, Vicarage Crescent, London, S.W.11, describes the Merit "Flex-Drum." Designed for

Trade and Technical Publications

the abrasive finishing of broad surfaces, the equipment is suitable for abrasive sanding, cleaning, polishing, and finishing on a continuous production rate.

The drum of the machine is formed of a series of "leaves" of coated abrasive cloth, fastened to the periphery of a mandrel to form an abrasive brush of any width up to 60-in. The resilience of the drum enables it to work either flat or uneven surfaces. By varying the grit grade, the surface finish of the workpiece can be controlled. A major advantage is that the drum cannot become loaded on soft stock, painted, or dirty surfaces.

Industrial Impregnations Ltd., 9 Willow Road, Pyle Estate, have issued a booklet detailing their technique for treating porosity in castings and other fabrications by impregnating the surface with a resin.

The technique can be used not only to reclaim castings that would otherwise have been scrapped, but as a pretreatment before applying a decorative finish. The system also provides a resistance against corrosion.

Reference is made in the July issue of The Nickel Bulletin to papers on extraction and determination of nickel and on direct-rolling of nickel strip; abstracts on nickel plating cover investigations concerned with the influence of plating variables and the quality of the deposits. Structural studies on nickel-containing non-ferrous alloys are noted, and in the section on nickel-iron alloys attention is directed to papers presented at a conference on magnetic materials.

The issue also includes the quarterly review of recent patent literature. Publishers are The Mond Nickel Co. Ltd., London, S.W.1.



Inset : R. W. Holmes.

No Punches Pulled In VEDC Answer To NUM Query

MEMBERS of the holloware division of the Vitreous Enamellers Development Council have reacted in no uncertain manner to an article that appeared in the May issue of "The British Manufacturer," the journal of the National Union of Manufacturers.

Posing the question "Hong Kong: Friend or Foe?" the article reviewed the economic growth of the industries in Britain's Far East colony.

Chairman of the division, Mr. R. W. Holmes, in a letter published in the September issue of The British Manufacturer castigates "the nauseating apologia for Hong Kong as the sort of arrant nonsense we have come to expect from politicians and Government departments," and goes on to express his view that the colony "is economically important only to a favoured few, in many cases deriving their profit from the worst forms of exploitation and degradation."

Mr. R. B. Williams, director and secretary of Jury Holloware Ltd., a member firm of the V.E.D.C., does not beat about the bush either in his answer to the question. "Hong Kong is a cesspool of commercial piracy," he states, "continuing as a British colony only by the grace and favour of the Red Chinese government . . . they realise it does more material damage to Britain than the Communists could accomplish by any sabotage."

Latest Developments in

PLANT, PROCESSES AND EQUIPMENT

Filtration and Rinsing Attachment

THE filtration and rinsing unit illustrated in Fig. 1 has been designed for the continuous removal of solids in liquid down to one micron particle size. Makers are Kerry's (Ultrasonics) Ltd., Warton Road, London, E.15.

Filtration is obtained by passing the cleaning liquid (by end filtration) through either a packed paper element or a ceramic element, suitable for use with either chlorinated or aqueous based solutions, respectively. The filtration rate is approximately 60 gal. per hr. through a $\frac{1}{4}$ -gal. capacity cleaning container.

The rinsing and filtration head can be positioned either in the left or right hand cleaning container on the 2-stage ultrasonic cleaning bath.

The unit provides for the continuous fine filtration of cleaning liquids to obtain a high standard of cleaning of small precision engineered components. Although the attachment is primarily intended for use with Mullard ultrasonic cleaners, it is suitable for other processes where very fine filtration is necessary, and can be adapted to handle a wide range of solvents.

Printed Circuit Dip Process

MOST photo resist materials used in printed circuit manufacturing can be removed by a 30-second dip in a new product, "Resistrip," according to an announcement from the Sel-Rex Corp., Nutley, New Jersey. The new cold stripping solution is said to provide two important advantages that can result in substantial increases in production: stripping time is reduced to a fraction of the time required through conventional means; and its use results in chemically cleaner surfaces ready for subsequent plating or dip soldering operations.

Using Resistrip, for which a patent is pending, any traces of photo resist not removed by the initial 30 second dip are said to show up clearly as brownish film. It is claimed this feature will eliminate rejects due to faulty plating and short circuiting often traceable to incomplete removal of photo resist. This "self-indicating" feature is also said to facilitate gauging of immersion-time required to remove photo resist of different types and varying thicknesses.

According to the manufacturer, Resistrip is non-combustible and long-lived. An "emulsifying

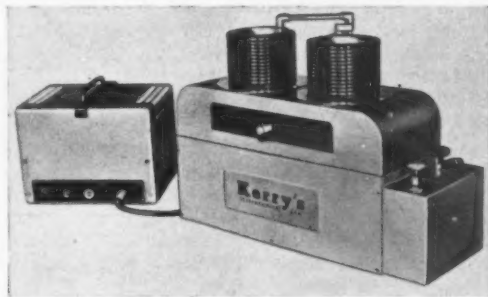


Fig. 1. A filtration and rinsing unit for use with an ultrasonic cleaner.

blanket" to retard evaporation makes the material economical in use. A technical bulletin describing the product is available on request. U.K. agents for Sel-Rex are M.L. Alkan Ltd., Stonefield Way, South Ruislip, Mddx.

Temperature Measurement for use with Thermocouples

USING their new series of D.C. amplifiers, Fielden Electronics Ltd., Wythenshawe, Manchester, have introduced an accurate and reliable equipment for temperature measurement using thermocouples. The product is a transducer for converting temperatures by thermocouple into a direct current for any D.C. instrument scheme and satisfies the requirement that the temperatures so transduced are equal in accuracy to the conventional D.C. potentiometers at present in wide use. It provides a very simple and inexpensive precision temperature indicator, and when used with a circular scale moving coil indicator of B.S.I. precision grade, the overall accuracy of the whole equipment can be better than 0.25 per cent even on $2\frac{1}{2}$ millivolt ranges, the makers say.

The amplifier is claimed to achieve a standard of accuracy equal to that associated with potentiometer measurements commonly used in industry, but with several advantages, and the instrument is intended for both industrial users and for laboratory measurements. Accuracy as a transducer is said to be as good as 0.1 per cent of range, and the instrument can be supplied in ranges as sensitive as $2\frac{1}{2}$ millivolts or 50°C . full scale. Although no slide-wire or servo-motor is used, the device is

(Continued in page 336)

fully potentiometric in operation and calls for no current from the thermocouple to make its measurement; thus it is independent of the length of lead used between thermocouple and instrument within operational limits. The output circuit is independent of any resistance change within wide limits and, therefore, the calibration is unaffected by the resistance of the transmission leads. The equipment is claimed to be stable to variations in supply voltage within ± 15 per cent.

The unit operates off 12 volts D.C. It consumes two milliamps in excess of the transmitted current, is consequently economical in operation and can, if required, be powered from a small battery for long periods, a feature that could be most useful for certain installations. It is possible to transmit over, say, telephone lines from remote points where a power supply is not available. The instrument is calibrated by a plug-in calibration unit and the range of any instrument can be changed in a few seconds. No standardisation is required once this is done. The electronic circuit is also in a sealed plug-in container, and jack plugs are provided for test and calibration on site without breaking circuit. Automatic cold-junction compensation is provided in the thermocouple amplifier unit, but the D.C. amplifier is available as a separate instrument for straightforward D.C. amplifier applications.

Dispenser for Factory Washroom

THE "Spenso" dispenser, illustrated in Fig. 2, consists of a bracket plugged to the wall on which rests a one gallon can. The pump unit clips on the bracket and down over the lip of the can and is tightened in position. The Spenso

Fig. 2.—This dispenser for factory washrooms fits a 1-gal. container



has a dipstick from which the contents of the can are easily checked. Filled merely by replacing one can with another, the unit simplifies dispensing a hand cleanser in a factory washroom. Makers are Deb Chemical Proprietaries Ltd., Forfar Chemical Works, Belper, Derbys.

Solvent-resisting Paint Coating

A SOLVENT-RESISTING paint coating, Detel S/R grade, has recently been introduced by Detel Products Ltd., Victoria Road, South Ruislip, Middlesex.

Either brush or spray application can be used, although the latter is to be preferred. It is resistant to a wide range of solvents, including: trichloroethylene, perchloroethylene, toluole, xylene, white spirit, benzole, butanol, cyclohexanone, amyl acetate and naphtha.

It can be air-dried or stoved and a catalyst is normally used for best results. In the case of trichloroethylene or perchloroethylene, stoving is not essential but best resistance to other solvents will be achieved if the coating is stoved at 120°C. for 30 minutes, the makers say.

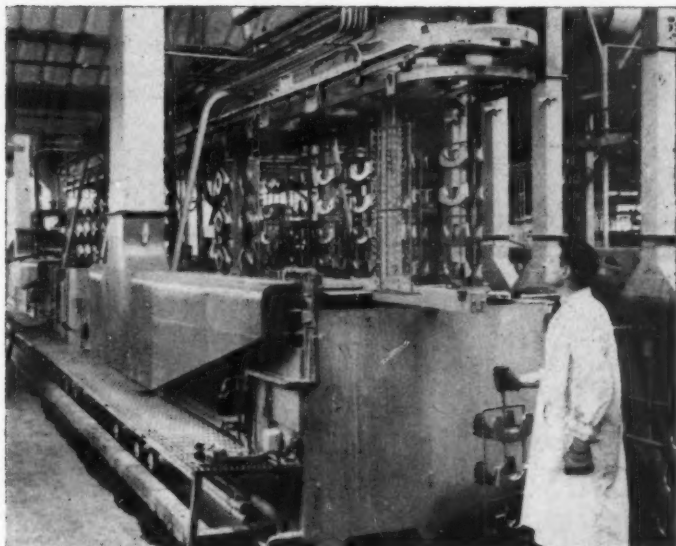
When air-dried, it will touch-dry quite quickly, but it does not reach maximum resistance to trichloroethylene until a curing period of about seven days at approximately 65°F. has elapsed. After the catalyst has been added, the pot life of the mixture is some 4-5 days.

Of special interest to the aircraft industry, Detel S/R grade is resistant to ester-based lubricant EEL 3, and if stoved for three hours at 90°C. it will also withstand the effects of Lockheed 22 hydraulic fluid.

No surface preparation is necessary before the application of the coating, degreasing with solvent being quite adequate. Even on polished aluminium, adhesion is said to be particularly good. Two coats of the paint should normally be applied, allowing in the case of air-dried films an interval of at least six hours. A test panel in the firm's laboratory performed satisfactorily under $\frac{1}{2}$ -in. bend test to DEF Specification 1053, method 13.

Spray Pack for Molybdenum Disulphide

AN anti-scuffing lubricant in an aerosol pack has been introduced by Rocol Ltd., Swillington, Leeds, to provide a convenient method of applying a lubricating film to metal or plastic surfaces. The spray container holds a basis of molybdenum disulphide and a bonding resin to effect retention of a film, plus a propellant. The vapour is non-toxic, non-corrosive and not harmful to human beings. The product should find a ready application where dry lubricants work in open conditions and may need replenishment. It is sold in tins of 12-oz. capacity.



Automatic Electroplating Plant

THE Efco-Udylite "Cyclemaster" range of return-type hydraulically operated automatic electroplating machines now available from the Electro-Chemical Engineering Co. Ltd., Woking, Surrey, is said to be particularly suitable for bright nickel and chromium plating and for nickel, zinc, cadmium or tin plating; it can be arranged for phosphating and other non-electrolytic processes (Fig. 3).

The machines incorporate the company's established transfer system, and are largely built from a number of standardised sub-assemblies. They are designed to allow a considerable flexibility of process sequence and output to meet customers' individual requirements, and it is claimed that less floor space is occupied than with any other machine of comparable production and a normal plating cycle.

Cyclemaster plants are being produced in three basic lengths, each of which can be supplied as a unit complete in itself, or can incorporate any one of six standard extended process tank assemblies: the basic plants measure 24 ft., 36 ft. and 48 ft. between transfer plates, and the extended assemblies range from 12 ft. to 27 ft. in 3 ft. increments. In each case, the process tank is of unit construction with welded partitions forming separate process compartments that (combined with a choice of three tank depths) enables a particularly wide range of process conditions and rack size to be catered for.

Rack dimensions may be from 12 in. by 30 in. up to 16 in. by 42 in., with a process load, including rack, of up to 45 lb. Machines can be designed to produce from 30 to 100 racks an hour according,

Fig. 3.—A number of standardised sub-assemblies provide flexibility of process sequence in this automatic plating plant.

to the process involved and the size of rack, and all are provided with variable time clocks for adjusting the time of immersion of racks in the process tanks.

The machines are shop assembled and tested before despatch and can be delivered in an assembled condition so that they can be rapidly installed and put into production.

Neoprene-based Protective System

A SYSTEM for applying an *in situ* protective lining or sheathing for metals and concrete exposed to unusually severe chemical attack has been introduced by Tretol Ltd., The Hyde, London, N.W.9., under the trade name of "Tretoprene 2C." Based on Neoprene synthetic rubber, a 0.015-0.020 in. thick film is claimed from a two brush application on primed surfaces. The makers claim that the system can withstand attack from a wide range of chemicals used in industry, and is also resistant to salts, oils and fats.

Industrial Vacuum Cleaner

A NEW industrial vacuum cleaner, the Martindale Model C, has been introduced by the Martindale Electric Co. Ltd., Westmorland Road, London, N.W.9. The model C will pick up dust, dirt, water and other fluids without any alteration being made to the unit, the makers claim.

The cleaner consists of a large bin, a carriage, a filter and a motor unit and housing. It is claimed to be unique in that the bin can easily be lifted out of its wheeled carriage and emptied, leaving the other parts of the cleaner where they are.

The compact filter incorporates 12 separate units each internally supported by a substantial coil spring to keep it rigid when in use, and is protected from contact with sharp particles of dirt and metal by a deflector on the inlet to the bin. Power is from a 1½ h.p. AC/DC electric motor. The bin carriage has solid rubber tyred wheels and the whole cleaner can be moved easily from one cleaning location to another.

Three quick release clips secure the motor unit to the bin casing, and a hose is supplied as standard.



Fig. 4.—Micro-section (500×) of a "duplex" nickel deposit showing the columnar structure of the High Speed Nivo deposit and the typical striated structure of the bright nickel deposit.

Duplex Nickel Coatings

THE development of duplex nickel coatings for improving the corrosion resistance of deposits has resulted in various systems and types of solution for the purpose. (Fig. 4).

W. Canning and Co. Ltd., Great Hampton Street, Birmingham, 18, have developed a system which combines the advantages of their well-known "Nivo" nickel, with the levelling and brightness of "B.Q.840" bright nickel solution. The dual deposit gives a corrosion protection equal to a polished Watts-type nickel without the need for polishing, it is claimed.

The initial deposit is obtained from high speed Nivo solution, a development of the "Nivo" which was first introduced in 1910 and has a reputation for ease of control and quality of deposit. This solution is simple, cheap to operate and does not require frequent heavy carbon treatment.

From the High Speed Nivo solution, components are transferred directly (without rinsing or "striking") into a B.Q.840 or B.Q.860 bright nickel solution to obtain a fully bright, levelled deposit.

The high speed Nivo solution is compatible with both B.Q.840 and B.Q.860 solutions, and there is no danger of laminated deposits being formed.

Drum Storage Unit

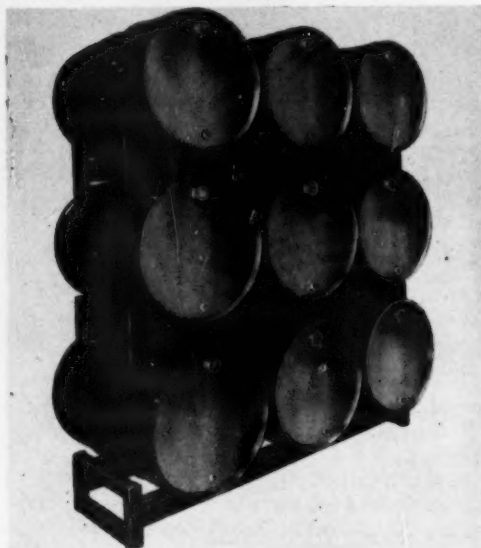
THE newly-designed drum pallet illustrated in Fig. 5 is constructed throughout with rectangular section hollow steel tubing. There are no crevices to hold moisture and it is therefore very suitable for use both outdoors and indoors.

Each unit carries 3 drums of 40/50 gal. size, and is handled by a fork lift truck, the fork clearance being 2½-in. deep.

Although strong enough to permit tiering four high, each unit is light enough for one man to

carry. The units are symmetrical and reversible, and, being compact, permit safe and close packing of drums in the minimum possible space. Makers are Powell and Co., Burry Port, Carm., S. Wales.

Fig. 5.—A drum storage pallet, easily manhandled when empty.



Remote-handling Tong

AN overwall tong has been introduced by Teleflex Products Ltd., Basildon, Essex, to enable radioactive and toxic materials to be handled remotely and safely. It obviates the necessity for remote handling at fixed stations, is sealed and does not require maintenance. The unit can be used for gripping, carrying and rotating, and because it is virtually free from back-lash, is sensitive and positive in action. It was designed in conjunction with A.E.R.E., Harwell.

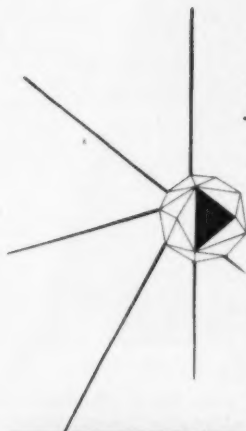
The control mechanism comprises a unique flexible shaft, one end attached to an operating mechanism, and the other to a tong head that is closed by a trigger mechanism, fitted with a fine adjustment for positive grip, and rotated by a twist grip handle. A quick-release trigger provides instantaneous release of the tong grip.

The body of the unit has an engraved scale of 3 markings, adjacent to the adjusting sleeve. Maximum and minimum fine adjustments of the tongs are indicated by red marks, and the intermediate position by a white mark. The support handle is adjustable for position and readily adapted to suit right or left-hand operation.

(Continued in page 340)

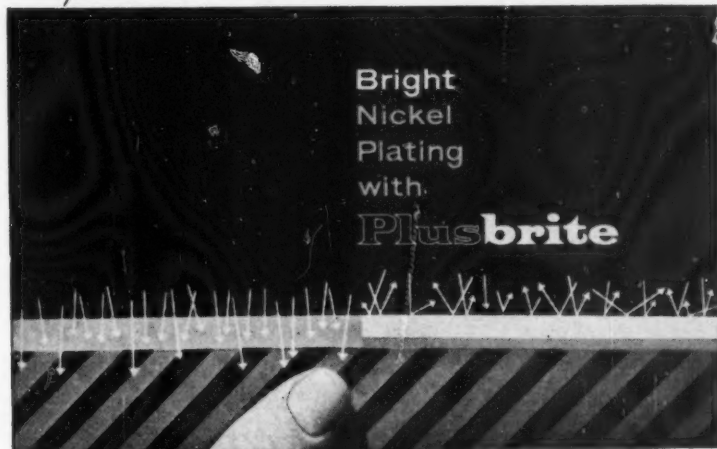
Plusbrite*

*provides the lowest priced
bright nickel plating process*



Plusbrite bright nickel plating provides high ductility, excellent levelling, low internal stress, good receptivity to chromium plate and good colour. Plusbrite addition agents are not removed by continuous filtration and they are easily controlled.

SEND FOR THIS FULLY DESCRIPTIVE LEAFLET



Albright & Wilson (Mfg) Ltd also supply Phosbrite chemical polishing solutions for copper, and aluminium and their alloys, together with chemicals for special processes in tin, copper and nickel plating and electrolytic polishing of ferrous metals.

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Name

Business Address

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w/635

Plant Processes, etc.

(Continued from page 338).

Shot Blast Helmet

A WIDER angle of vision and greater comfort are among the features claimed for the new Black Knight shot blast helmet introduced by the R. F. D. Co., Godalming, Surrey.

All parts are replaceable and spares can be kept in hand so that it need never be returned to the manufacturers for maintenance or servicing. Since all parts are washable, a high standard of hygiene can be maintained. Fig 6. shows a worker wearing the helmet and cape.

The specially reinforced shell is moulded in glass fibre and covered with a tight fitting Latex envelope made in two window sizes.

The outer windows are 0.010 in. cellulose acetate and the inner window is 0.080 in. Perspex.

An optional extra is a new Mark II control box that incorporates an activated carbon filter cartridge



Fig. 6.—Glass fibre shot blast helmet.

to free the air supply from traces of compressor oil; it is capable of absorbing several hundred times its own volume in oil vapour, the makers say.

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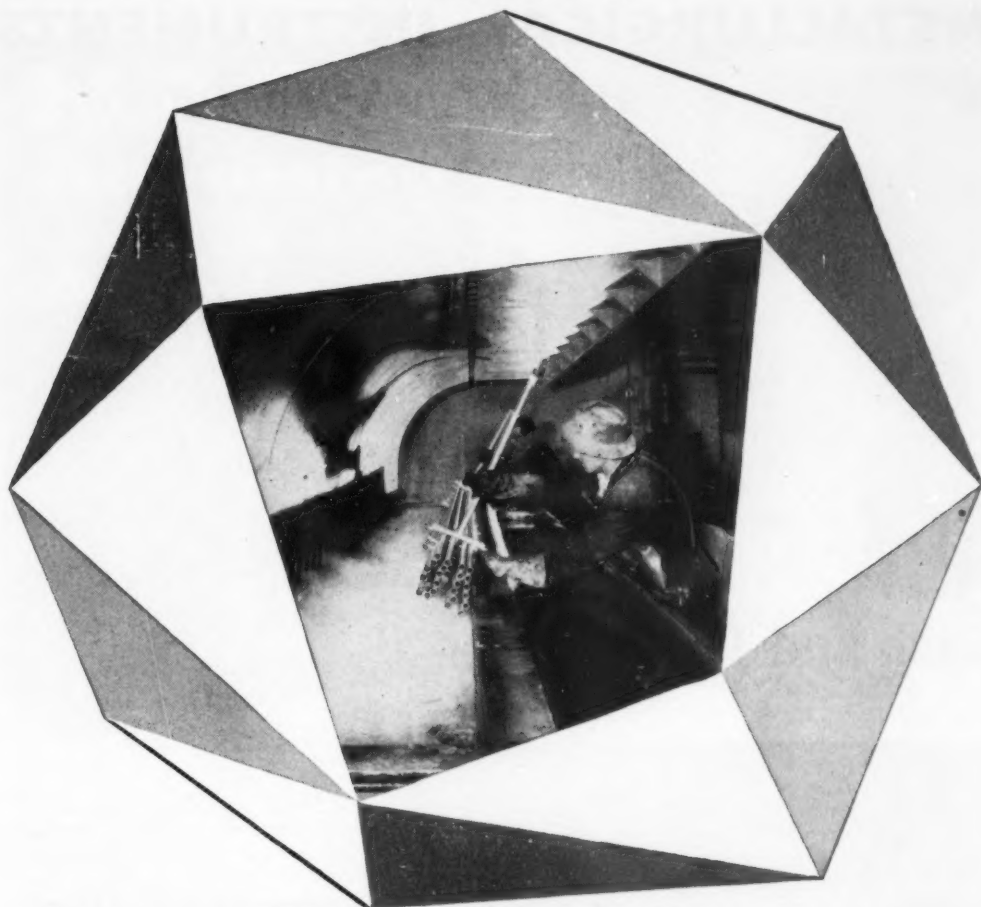
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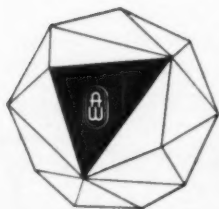
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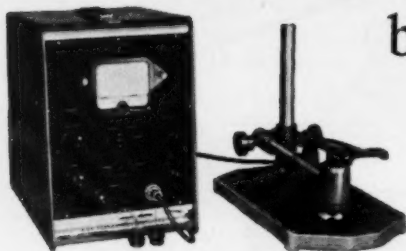
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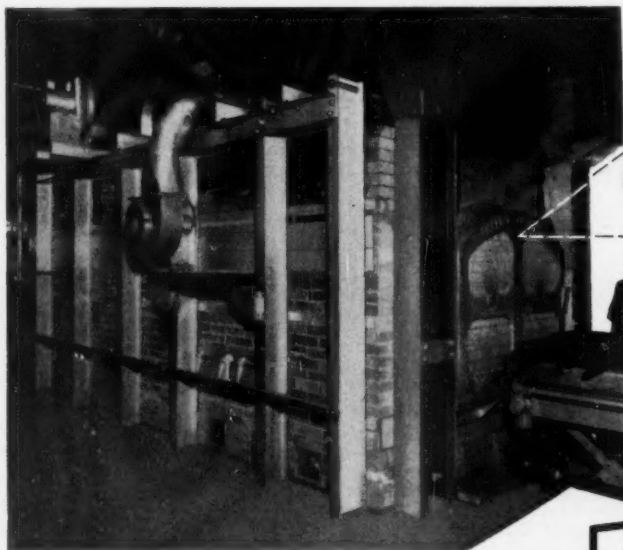


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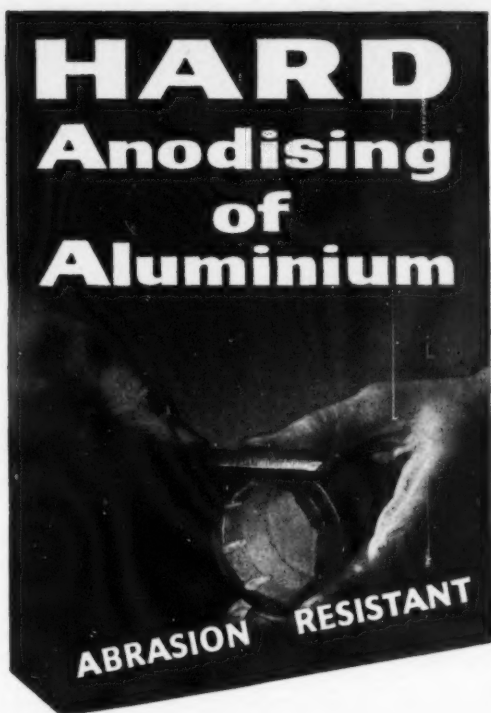
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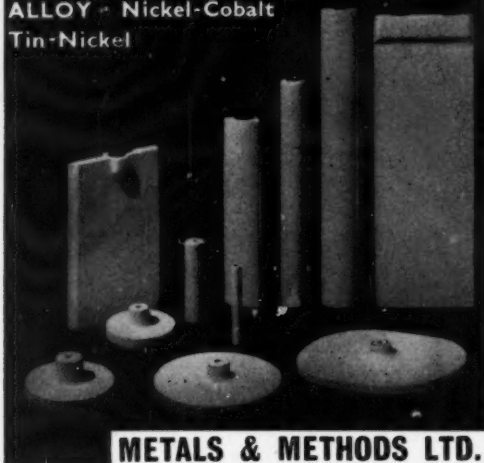
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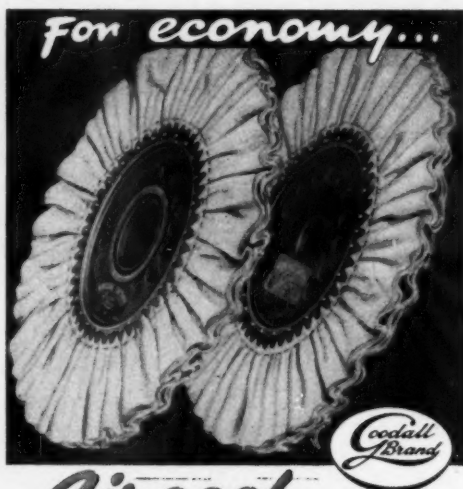
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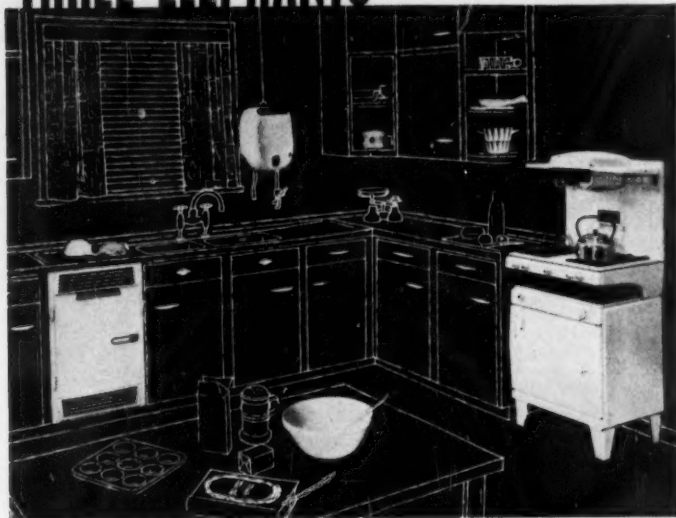
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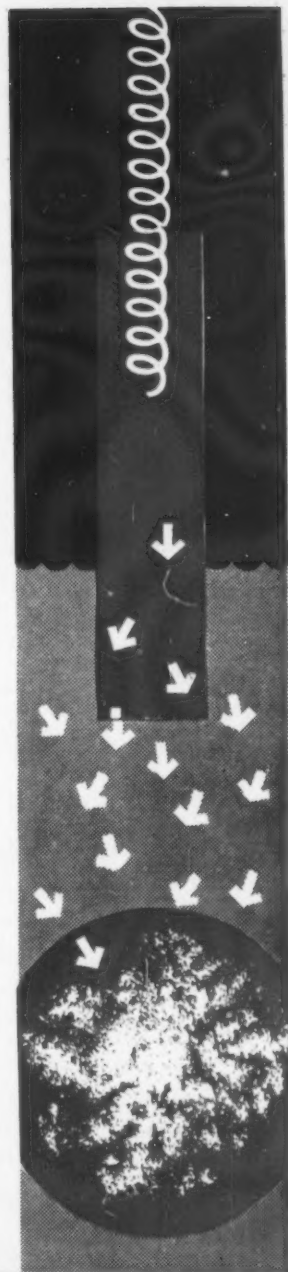
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